

MONITORING OF DOWNSTREAM SALMON AND STEELHEAD
AT FEDERAL HYDROELECTRIC FACILITIES - 1987

Annual Report

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INTRODUCTION

The seaward migration of salmonid smolts was monitored by the National Marine Fisheries Service (NMFS) at four sites on the Snake-Columbia River system. This project is a part of the continuing program to monitor Columbia Basin salmonid stocks coordinated by the Fish Passage Center (FPC). Funding was provided by the Bonneville Power Administration (BPA).

Sampling sites were Lower Granite, McNary, John Day and Bonneville Dams, and also included collection of data from NMFS research units sampling the bypass system in powerhouses #1 and #2 (PH#1, PH#2) at Bonneville Dam. Data from these sites provided information mainly for evaluation of smolt survival, travel time, migration timing and for water budget and spill management as required by Fish Passage Managers (FPM) and analysts of the FPC. To secure these data, it was necessary to monitor and index smolt passage which involved: 1) systematic sampling of the smolt migration from late March through July at Lower Granite Dam, late March through late October at McNary Dam, April through November at John Day Dam, and generally mid to late March through late November, depending on the sampling device(s) at Bonneville Dam; 2) recording brands; and 3) daily reporting of all pertinent fish capture and condition data, as well as dam operations and river flow data for passage estimates and travel indices to the FPC Fish Passage Data Information System (FPDIS).

METHODS AND MATERIALS

Monitoring the smolt migration at Lower Granite and McNary Dams was as reported for 1984 (Johnsen, et. al., 1984) and continued in 1985 and 1986. A portion of the total number of smolts from the gateway collection system was sampled by time at a target rate of --"the lesser of 3% of the estimated weekly outmigration or, 10% of the weekly total of smolts collected or bypassed....", based on the FTOT Annual Work Plan for 1987. Some increase above the target rate was allowed to collect sufficient numbers of yearling spring chinook smolts to mark for the needs of the transport evaluation study. (Details to be reported in the 1987 FTOT annual report). Sampling methods at John Day Dam were the same as 1986; the airlift pump system in Unit 3 (gateway B) was utilized. At Bonneville Dam sampling at PH#1 was by gateway dipnetting (DN) during the spring migration and by trapping in the auxiliary water supply (AWS) channel during the summer/fall period. Also, as in 1986, the gateway collection and bypass channel was sampled by NMFS research units using the downstream migrant facility in PH#1 (DSM1) and the downstream migrant facility in PH#2 (DSM2). (The DSM and methods were described by Gessel, 1986, and by McConnell and Muir, 1982, for PH#1 and PH#2 respectively). Smolt capture data reported for DSM1 and DSM2 were from NMFS research operations; flow data were obtained from the Corps of Engineers (CoE).

The sampling periods are shown in Figure 1. Sampling frequencies for the different sites are as follows:

Lower Granite Dam -- Daily; 24 hour cumulative sample.
3/26 to 7/31.

McNary Dam ----- Daily; 24 hour cumulative sample.
3/27 to 10/29.

John Day Dam ----- Daily; 24 hourly samples.
4/1 to 11/30.

Bonneville Dam
PH#1, dipnet -- Daily; 24 hour cumulative sample.
3/27 to 6/14.

PH#1, AWS ----- Daily; 8 hourly samples.
6/2 to 11/30.

PH#1, DSM1 ----- Five days per week; 8 hourly samples
plus periodic diel samples.
3/13 to 11/20.

PH#2, DSM2 ----- Four days per week; 24 hour
cumulative sample.
3/10 to 11/20.

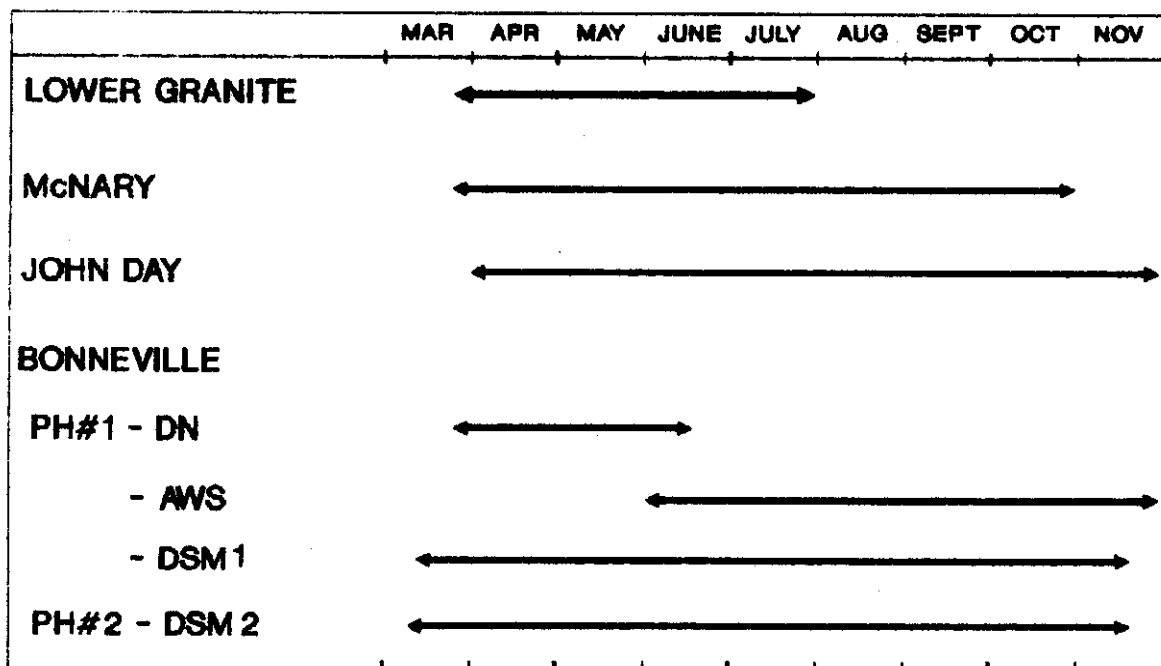


FIGURE 1. Smolt monitoring season by site, 1987.

(DN - dipnetting; AWS - auxiliary water supply trap; DSM - downstream migrant facility.)

RESULTS AND DISCUSSION

Sampling results for field season 1987 are presented in Table 1. The results of the hands-on assessments of smolt movement into or through the hydroelectric facilities at the listed sites are summarized. Included in the appendices is a graphic coverage of the passage index with flow for Lower Granite and McNary Dams. Some duplication may occur in other summaries.

Lower Granite Dam

Sampling activities at Lower Granite Dam this season were essentially the same as in 1986, except that no distinction was made between chinook yearlings (chinook 1) and chinook subyearling (chinook 0) as was suggested by FTOT. No significant operational problems were encountered through the season. Monitoring activities were performed jointly with Washington Department of Wildlife (Formerly Washington Dept. of Game).

The pre-anesthetizer (PA) installed in 1986 and was modified prior to the 1987 season as follows:

1. Electrically powered crowder gates with a conveniently located control switch were installed.
2. A semitransparent transport pipe from the PA compartment to the sorting trough replaced the opaque pipe.
3. An improved seal was installed on the PA compartment inlet (knife) gate.

Operator experience along with these additions and modifications made a more consistent and timely delivery of fish to the sorting trough than was achieved the previous season. The improvements achieved in operation of the PA system in 1987 also resulted in greater efficiency in the total sample processing, sorting, measuring, weighing, brand reading, and mark application, as well as a benefit to the survival of these fish (based on delayed mortality studies ^{1/}). The more effective PA operation also resulted in a substantial (50%) savings in anesthetic as compared to 1986.

Flows and smolt sample numbers are presented for Lower Granite Dam in Appendix A. The inclusive dates for the 10 to 90 percent segment of passage for chinook smolts were 4/18 to 5/8 and for steelhead, 4/28 to 5/29. Passage of other salmonid species were of substantially lower numbers (<0.1% of the total sample).

McNary Dam

Monitoring activities at McNary Dam were routine and essentially the same as 1986 except for one major change, the installation of a new sample holding tank with built-in PA compartments. Testing the system was necessary before efficient and consistent operation was possible. Operational techniques learned through experience

1/ Personal communication, Gene Mathews, NMFS, Seattle, WA.

TABLE 1. -- Summary of 1987 smolt sampling activities at Lower Granite, McNary, John Day and Bonneville Dams.

SPECIES	SITE	TOTAL SAMPLE	BRANDS IN SAMPLE	ESTIMATED ^{1/} COLLECTION	ESTIMATED ^{2/} FPI
CHINOOK 1's	LOWER GRANITE	137,156	2,523	2,499,018	2,499,213
	McNARY	241,484	7,979	3,450,127	4,044,190
	JOHN DAY	84,455	1,890	84,455	1,020,768
	BONNEVILLE PH#1 DN ^{3/}	63,596	750	63,596	853,798
	BONNEVILLE PH#1 AWS	118	2	126	N/A
	BONNEVILLE PH#1 DSM	28,828	323	120,108	N/A
	BONNEVILLE PH#2 DSM	6,461	221	6,461	N/A
CHINOOK 0's	LOWER GRANITE	N/A ^{4/}	N/A	N/A	N/A
	McNARY	401,629	3,237	7,029,401	7,044,175
	JOHN DAY	95,505	1,024	95,505	760,605
	BONNEVILLE PH#1 DN	42,326	1	42,326	533,450
	BONNEVILLE PH#1 AWS	3,081	1	3,272	N/A
	BONNEVILLE PH#1 DSM	61,925	11	371,000	N/A
	BONNEVILLE PH#2 DSM	5,438	1	5,438	N/A
STEELHEAD	LOWER GRANITE	185,519	2,265	3,000,478	3,000,682
	McNARY	85,930	7,540	1,004,967	1,191,537
	JOHN DAY	23,988	1,608	23,988	300,410
	BONNEVILLE PH#1 DN	8,868	320	8,868	141,673
	BONNEVILLE PH#1 AWS	520	17	560	N/A
	BONNEVILLE PH#1 DSM	8,760	286	38,306	N/A
	BONNEVILLE PH#2 DSM	823	15	823	N/A
COHO	LOWER GRANITE	2	0	18	18
	McNARY	30,726	39	225,961	255,512
	JOHN DAY	13,200	4	13,200	170,353
	BONNEVILLE PH#1 DN	26,529	0	265,529	430,532
	BONNEVILLE PH#1 AWS	264	0	304	N/A
	BONNEVILLE PH#1 DSM	23,188	0	102,228	N/A
	BONNEVILLE PH#2 DSM	3,940	0	3,940	N/A
SCKEYEE	LOWER GRANITE	54	0	724	724
	McNARY	69,929	722	615,593	690,946
	JOHN DAY	11,911	107	11,911	145,232
	BONNEVILLE PH#1 DN	4,464	46	4,464	66,514
	BONNEVILLE PH#1 AWS	123	1	138	N/A
	BONNEVILLE PH#1 DSM	4,079	37	18,733	N/A
	BONNEVILLE PH#2 DSM	642	2	642	N/A
TOTAL CATCH	LOWER GRANITE	322,731	4,788	5,500,238	5,500,637
	McNARY	829,698	19,517	12,326,049	13,226,360
	JOHN DAY	229,059	4,633	229,059	2,397,368
	BONNEVILLE PH#1 DN	145,783	1,117	145,783	2,025,967
	BONNEVILLE PH#1 AWS	4,106	21	4,400	N/A
	BONNEVILLE PH#1 DSM	126,780	657	650,375	N/A
	BONNEVILLE PH#2 DSM	17,304	239	17,304	N/A

Data Source: Fish Passage Data Information Service

1/ Collection counts are adjusted for the sample rate at Lower Granite and McNary Dams only.

Total counts may vary from other published summaries because of different time periods for daily estimates.

2/ Passage Index is collection count adjusted for rate of flow.

3/ DN=dipnetting, AWS=Auxillary Water Supply, DSM=DownStream Migrant facility. Bonneville DN includes totals from gatewells 9-B and 10-B of powerhouse #1.

4/ No distinction was made between Chinook 1's and Chinook 0's at Lower Granite Dam.

provided the key to timely delivery of anesthetized fish to the sorting trough at a rate sorters could manage.

The observed benefits of the new sample holding tank and PA were as follows;

1. Increased water volume (about 28%) and fish holding capacity;
2. More efficient crowder system in terms of personnel required and less crowding stress and descaling of sample fish;
3. Reduced immediate handling mortality; usually sample (handled) fish show an increased mortality compared to other collected (non-handled) fish held in transport raceways. All species of sample (handled) fish show an increased mortality of about 0.9 percent in 1986 (Koski, et. al., 1987) but in 1987 it decreased to about 0.1 percent ^{2/};
4. Less foam occurred (from fish mucous) in the recirculated anesthetic system, as well as a sharp reduction in quantity of fish scales cleaned from the system filter; this is mainly attributed to minimal dipnetting of fish out of the water and the reduction of frantic jumping and thrashing of those fish;
5. Reduced delayed mortality as measured by a subsample of marked fish (CWT, branded and adipose clipped) held for 48 hours ^{3/}. (Details to be reported in the annual report of the transport marking study).

This new installation should provide continuous benefits. Some additional improvements should be made, such as: 1.) the addition of an electrically powered crowder mechanism, 2.) enlarging the chute leading into the pipe that transports fish into the sorting trough, and 3.) installation of a hoist to raise knife gates at the entrance to the pre-anesthetizer compartments.

Flows and sample numbers are listed in appendix B. The inclusive dates for the 10 to 90 percent segment of passage are:

Chinook 1	- - - - -	4/28	-	5/19
Chinook 0	- - - - -	6/20	-	7/16
Steelhead	- - - - -	5/2	-	5/24
Coho	- - - - -	5/13	-	5/31
Sockeye	- - - - -	5/8	-	5/31

2/ Personal communication, Susan Knapp, CoE, McNary Dam.

3/ Personal Communication, Gene Mathews, NMFS, Seattle, Washington.

In contrast to 1986, chinook fry (small 0-age chinook, $\leq 60\text{mm}$) in 1987 comprised only a small portion (estimated at $< 10\%$) of the chinook 0 sample in the period of their highest occurrence, late May to early June. In 1986 chinook fry comprised about 75 percent of the chinook 0 sample during this time.

John Day Dam

Monitoring activities at John Day Dam were consistent with the 1986 season. No major operational problems occurred. River flow, Unit 3 discharge, fish passage patterns by species and diel passage patterns are presented in Appendix C for the 1987 season. The 10 to 90 percent segment of smolt passage by John Day Dam occurred during the following periods:

Chinook 1	- - - - -	5/3	-	6/1
Chinook 0	- - - - -	6/7	-	9/16
Steelhead	- - - - -	5/1	-	5/29
Coho	- - - - -	5/6	-	5/31
Sockeye	- - - - -	5/14	-	6/6

Diel passage patterns (Appendix C, Figures 1-51 ^{4/}) were consistent with 1986 (Johnsen, et al., 1986) and as previously documented by Sims, et al. (1976 and 1981), ie., the majority of passage (75-95%) typically occurs during night time hours at John Day Dam. Reversals of this pattern, though infrequent, do occur. One such reversal occurred in mid May (Appendix C, Figure 16) when about 59 percent of the chinook 1 passage was during daytime hours. Chinook fry ($\leq 60\text{mm}$) show a more consistent daytime passage compared to other juvenile salmonids; during the peak passage of chinook fry, mid to late May (Appendix C, Figures 16 and 17), about 75 percent occurred during the daytime, compared to 70 percent in 1986. Chinook fry comprised about 87 percent of the chinook 0 catch, however, the total number (about 780) was estimated to be less than 5 percent of the number captured in 1986 (about 20,000).

The fish passage index (FPI) and the hydroacoustics index (HI) are presented in Figure 2 for the concurrent sample period, June 8 through August 15. A cursory review of these indices indicate that most trends, high and low, are similar as to date, but the magnitude varies. The FPI is based on a single sample point, unit 3, as compared with the HI which has multiple transducer sample points distributed across the Dam, and therefore the HI may measure the variable horizontal distribution of passage by the dam better than Unit 3.

4/ Minimum number for weekly catch shown is 500 for each species.

FISH PASSAGE INDEX/HYDROACOUSTICS

John Day Dam, 1987

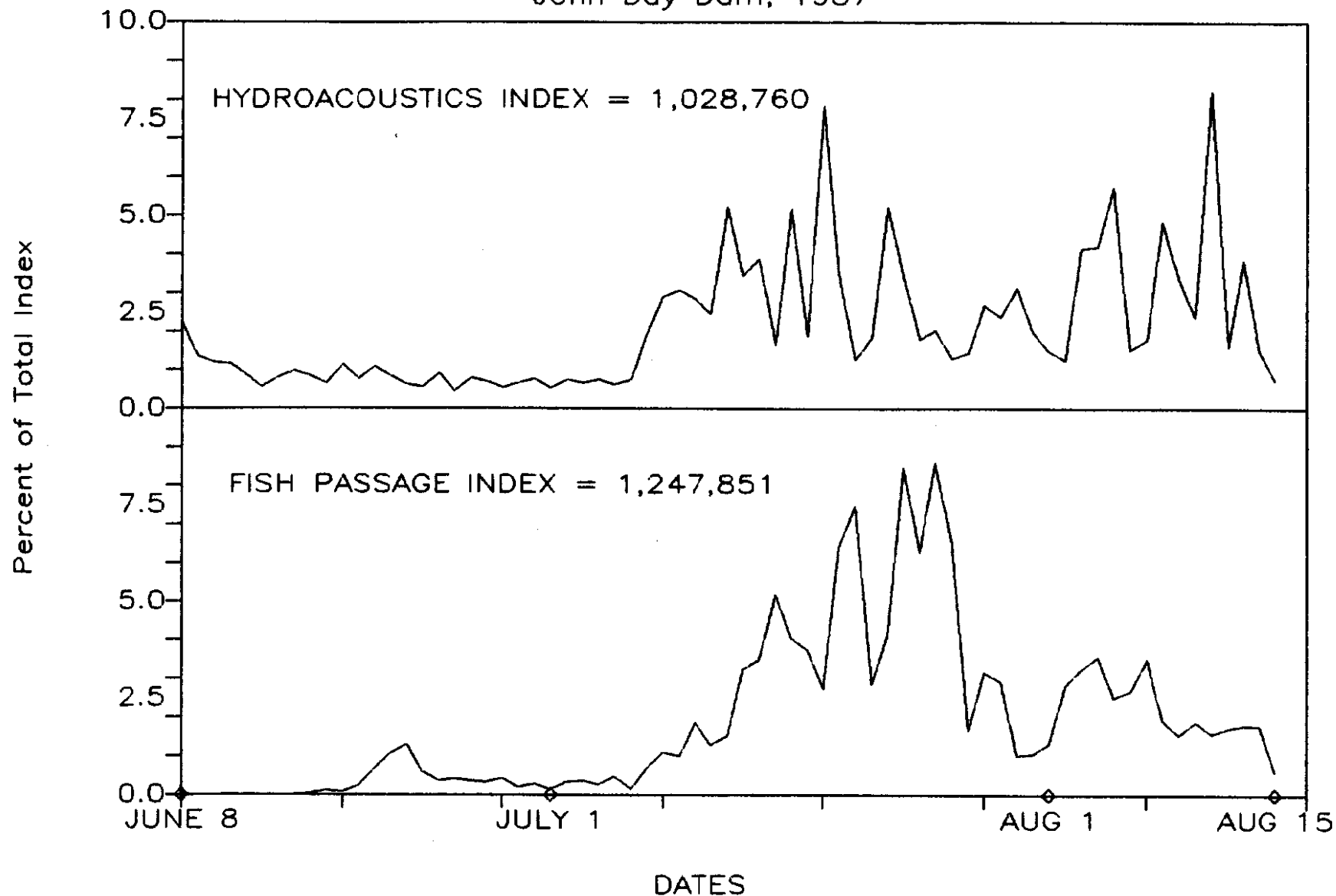


FIGURE 2. Smolt passage index compared with hydroacoustics index during concurrent sampling, 1987.

Bonneville Dam

Gatewell dipnet catch data initially from Unit 10, gatewell B, and later from Unit 9, gatewell B, of PH#1 were collected throughout the spring. In the summer/fall season, sampling was accomplished by trapping migrants passing through the AWS channel of PH#1. The shift from Unit 10 to 9 resulted from debris clogged trash racks in Unit 10 which necessitated the unit shut down. Sampling was shifted to Unit 9 which usually has had fewer debris problems compared to Unit 10, but also fewer fish. Consistent sampling was considered more important than large numbers of fish.

Smolt capture data from DSM1 and 2 were made available by NMFS research units for reporting to FPDIS by our office. Analysis will be presented in the report to the CoE by the Coastal Zone and Estuarine Studies Division of the Northwest and Alaska Fisheries Center.

The chronological pattern of catch data from gatewell dipnetting, operation of the AWS trap, and flows are presented in Appendix D, Figures 1-19. Generally, periods of the highest fish passage were as follows:

Species	Spring (DN)	Summer/Fall (AWS)
Chinook 1	Mid April - mid May	N/A
Chinook 0	Mid April; late May- early June	Early June; late June- late July
Steelhead	Mid April & mid May	N/A
Coho	Late April & early May	N/A
Sockeye	Mid April; mid May, & late May-early June	N/A

Catches in the AWS trap ranged widely from one to over 800 smolts in an eight hour period and by the first of August, about 95 percent of the total capture (4100) had been made. Chinook 0's comprised the majority (75%) of the smolts collected.

Gatewell DN catches in PH#1 and AWS trap catches for the concurrent sampling period, 6/3 to 6/14 are shown below:

	Chinook 1's	Chinook 0's	Steelhead	Coho	Sockeye
Gatewell DN	1,633	17,120	562	2,049	917
%	7.3	76.8	2.5	9.2	4.1
AWS Trap	24	498	236	235	117
%	2.1	44.8	21.3	21.2	10.5

Comparing the species composition of the two sampling methods shows a substantial difference. It is probable the gatewell catch more nearly represents the actual species composition passing PH#1. Considering this difference in species composition and the low passage numbers through the AWS channel, it is not likely the AWS trap could provide reliable passage estimates.

SUMMARY

The 1987 smolt monitoring project of the National Marine Fisheries Service provided data on the seaward migration of juvenile salmon and steelhead at Lower Granite, McNary, John Day, and Bonneville Dams. All pertinent fish capture and condition data as well as dam operations and river flow data were provided to the FPDIS for use by FPC in determining migration timing, and for water budget and spill management.

RECOMMENDATION

We recommend that the AWS trap at Bonneville Dam not be utilized as the only means of estimating smolt passage through Powerhouse #1.

ACKNOWLEDGMENTS

Support for this smolt monitoring project comes from the region's electrical ratepayers through the Bonneville Power Administration.

The success of this program continues to involve cooperative interaction with the Northwest and Alaska Fisheries Center, Coastal Zone and Estuarine Studies Division in both personnel and facilities of the Pasco, North Bonneville and Rufus Field Stations. It is appreciated.

On-site biologists, assistants and others of the Corps of Engineers provided valuable guidance and assistance at each sampling site: Lower Granite, McNary, John Day and Bonneville Dams.

We acknowledge the very capable efforts of our biologists, technicians, maintenance and contract persons; their work was vital. Also, of particular significance was the assistance provided by the Washington Dept. of Wildlife at Lower Granite Dam.

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APPENDIX A
LOWER GRANITE DAM - 1987

FIGURE	TITLE	PAGE
1	RIVER FLOW	A-1
2	PASSAGE PATTERN	A-1

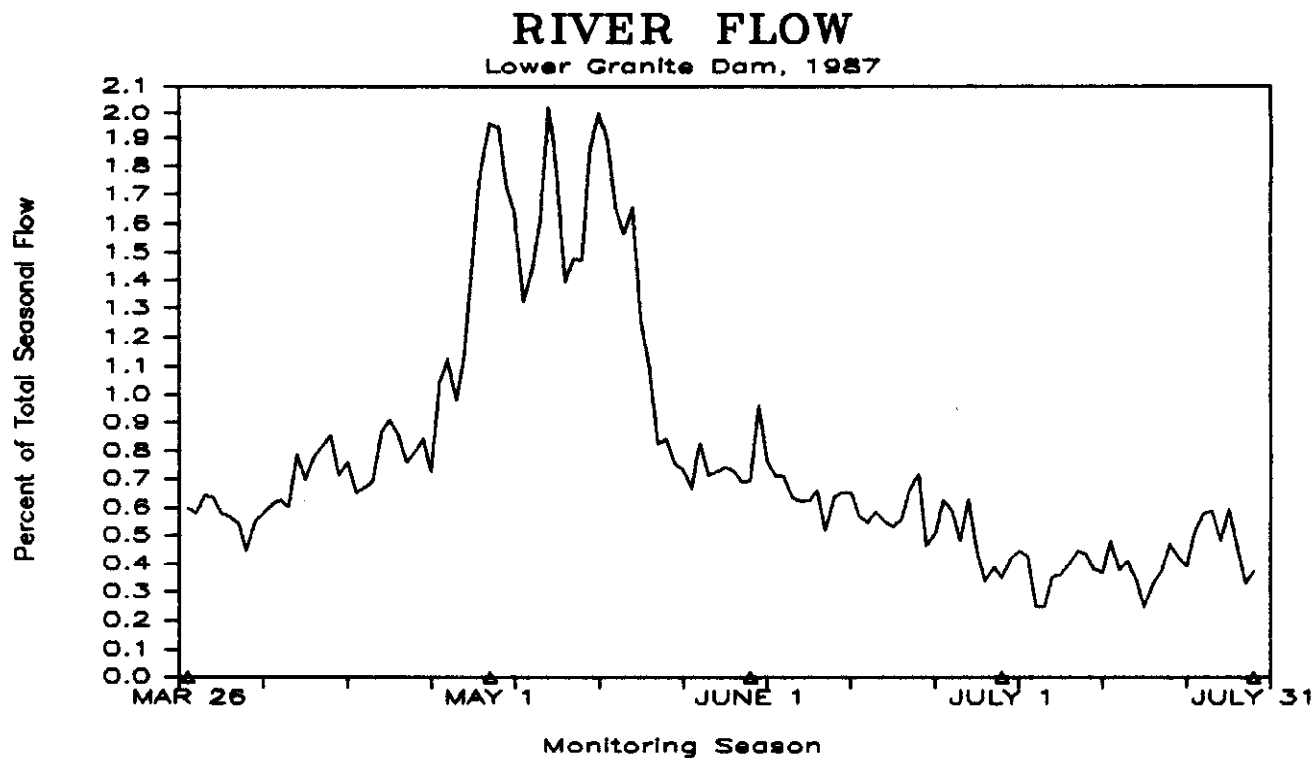


FIGURE 1

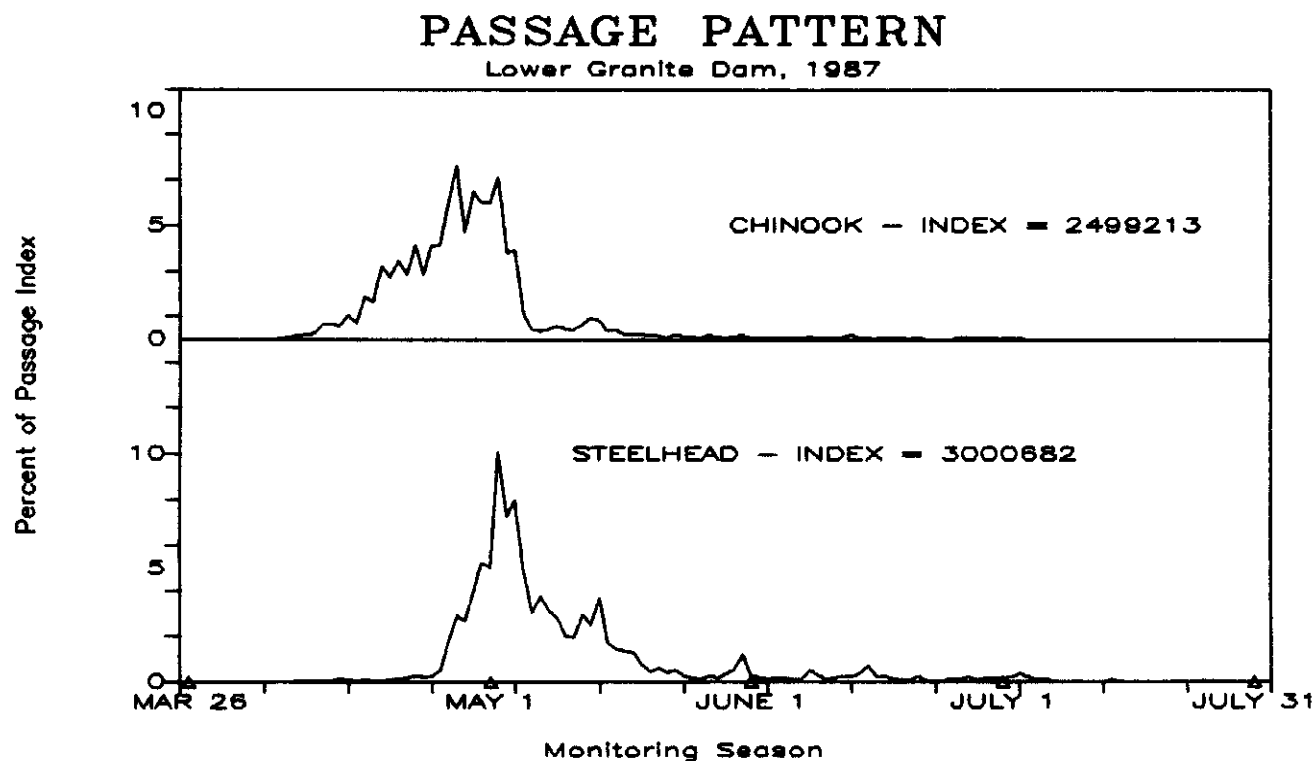


FIGURE 2

APPENDIX B
McNARY DAM - 1987

FIGURE	TITLE	PAGE
1	RIVER FLOW	B-1
2	PASSAGE PATTERN	B-1

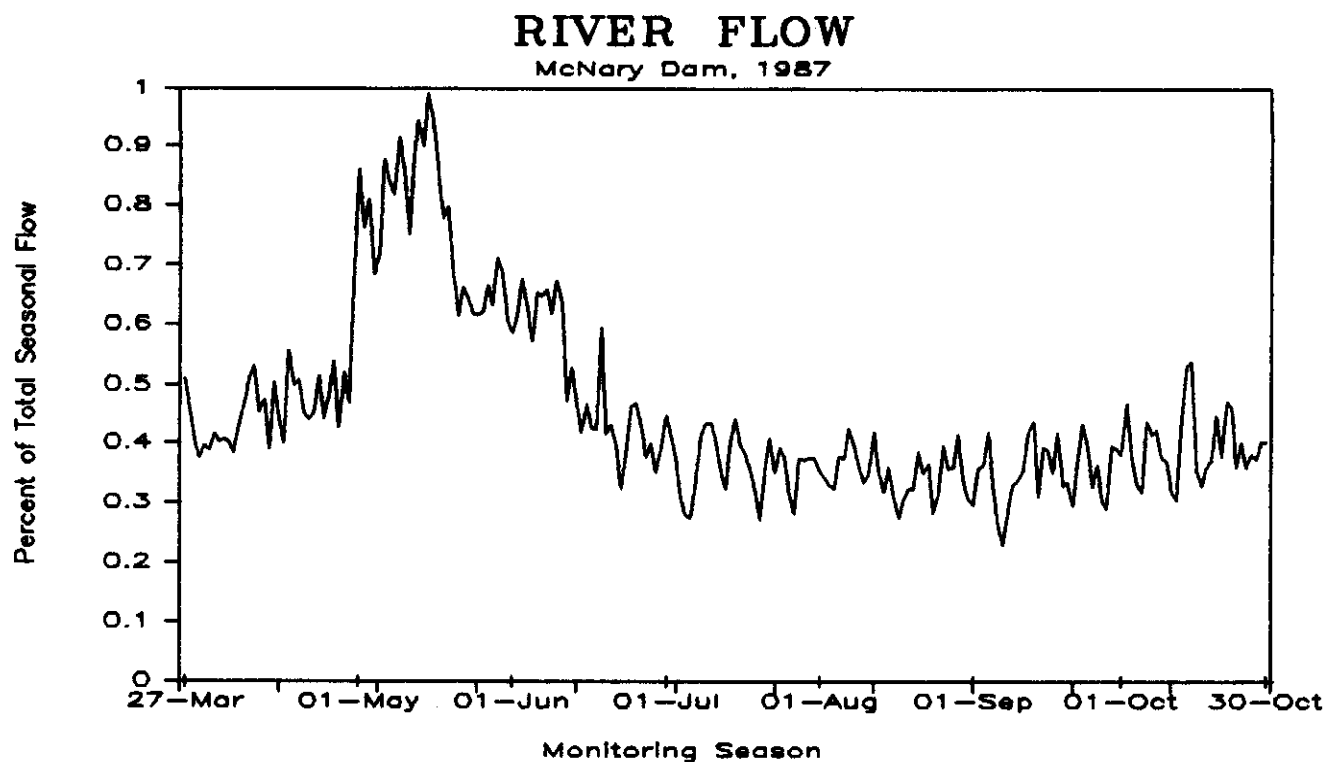


FIGURE 1

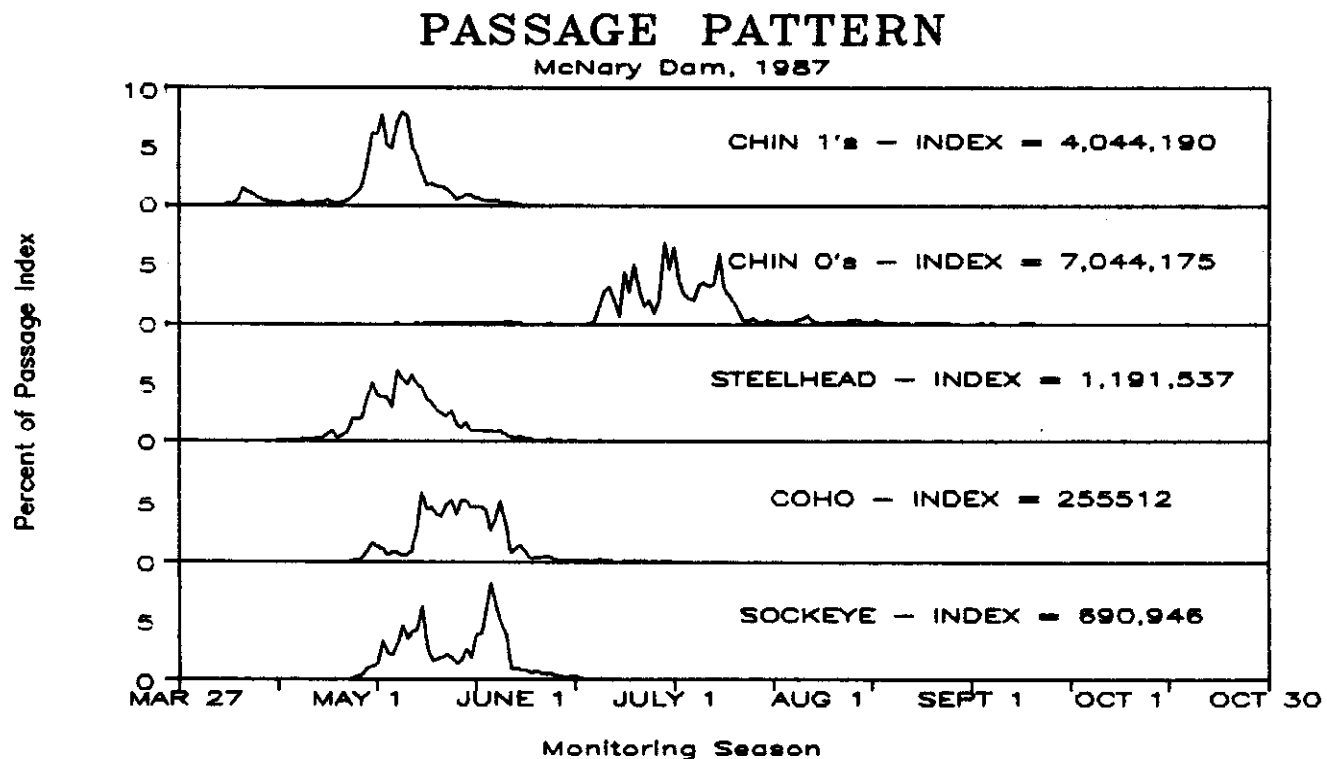


FIGURE 2

APPENDIX C
JOHN DAY DAM - 1987

FIGURES	TITLES	PAGES
1 -15	WEEKLY DIEL PATTERN - CHINOOK 1's	C-1 TO C- 8
16-33	WEEKLY DIEL PATTERN - CHINOOK 0's	C-9 TO C-17
34-41	WEEKLY DIEL PATTERN - STEELHEAD	C-18 TO C-21
42-46	WEEKLY DIEL PATTERN - COHO	C-22 TO C-24
47-51	WEEKLY DIEL PATTERN - SOCKEYE	C-25 TO C-27
52	RIVER FLOW/UNIT 3 FLOW	C-29
53	PASSAGE PATTERN - CHINOOK 1's	C-29
54	PASSAGE PATTERN - CHINOOK 0's	C-30
55	PASSAGE PATTERN - STEELHEAD	C-30
56	PASSAGE PATTERN - COHO	C-31
57	PASSAGE PATTERN - SOCKEYE	C-31

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

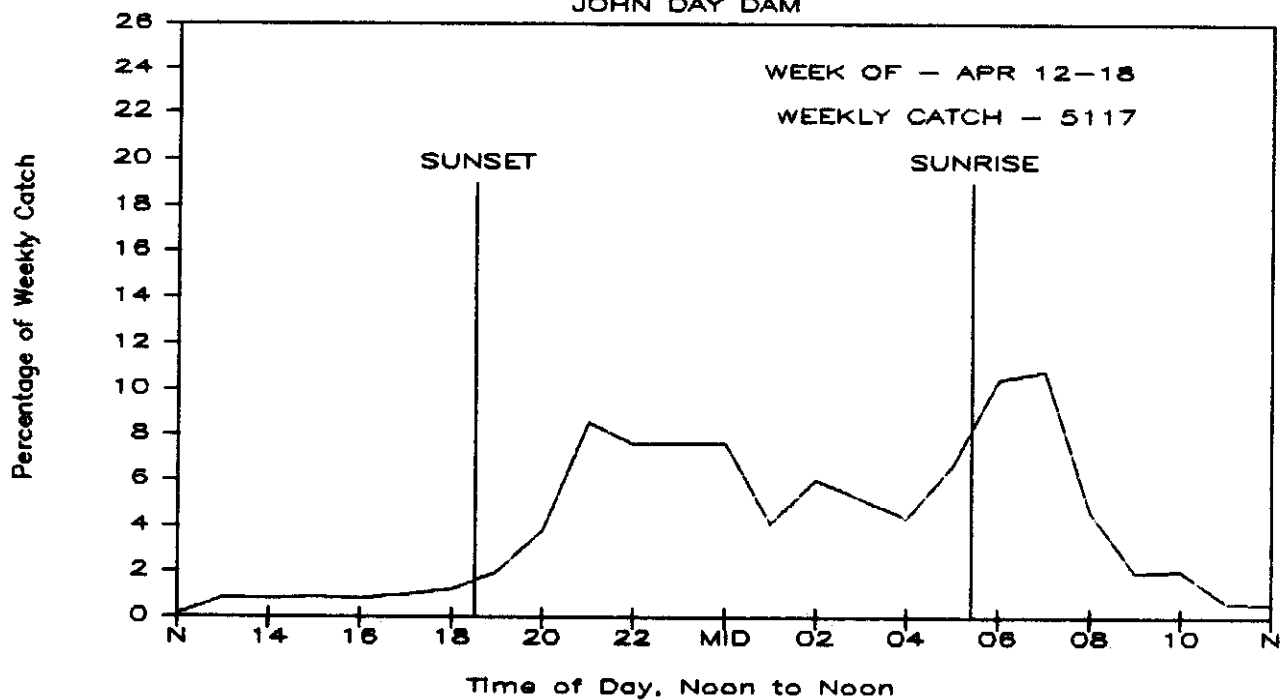


FIGURE 1

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

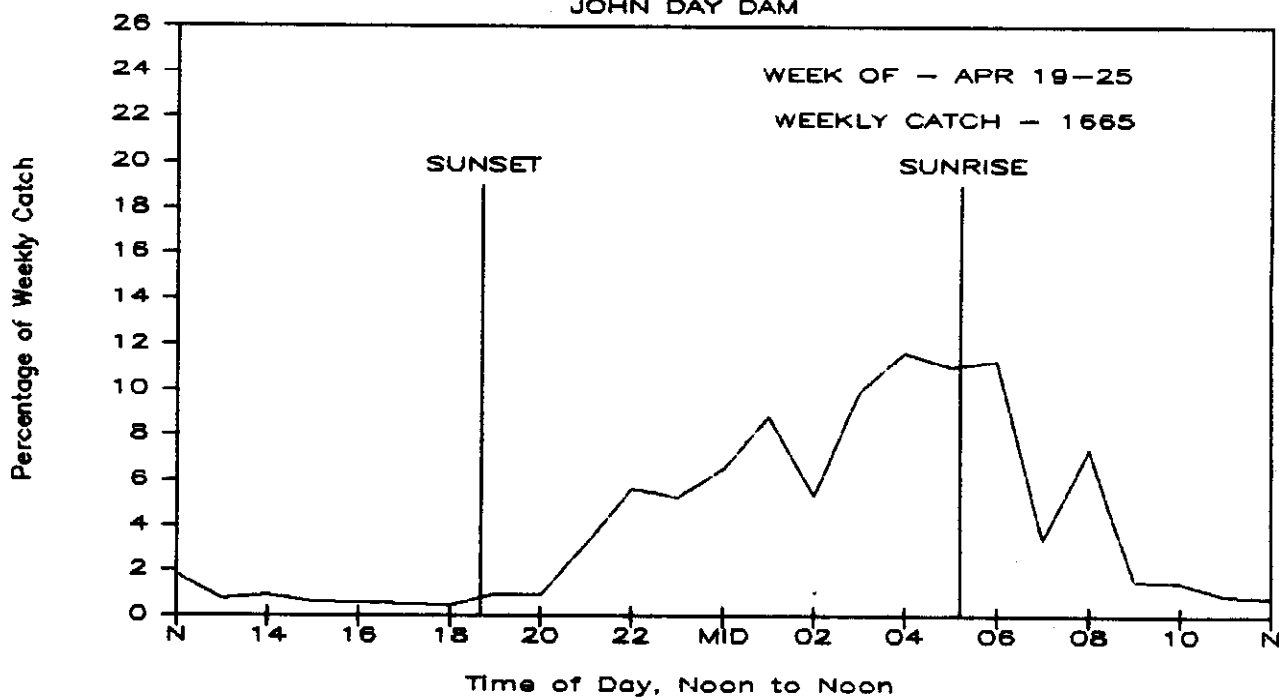


FIGURE 2

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

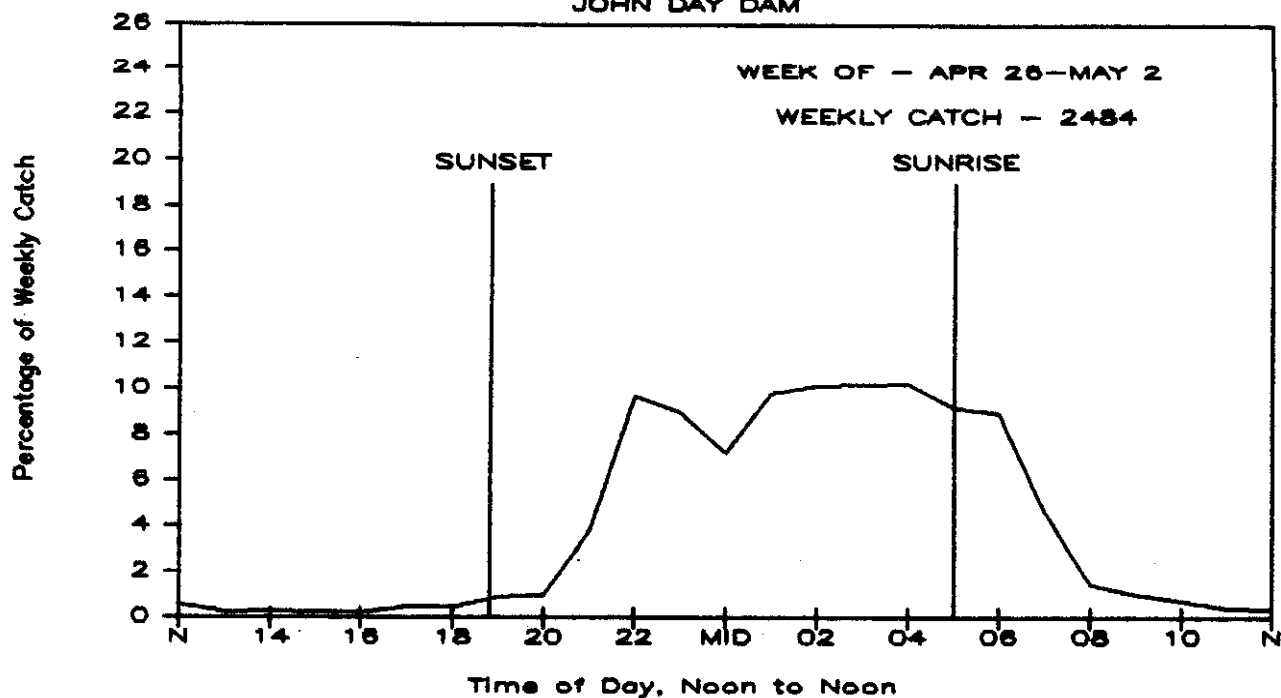


FIGURE 3

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

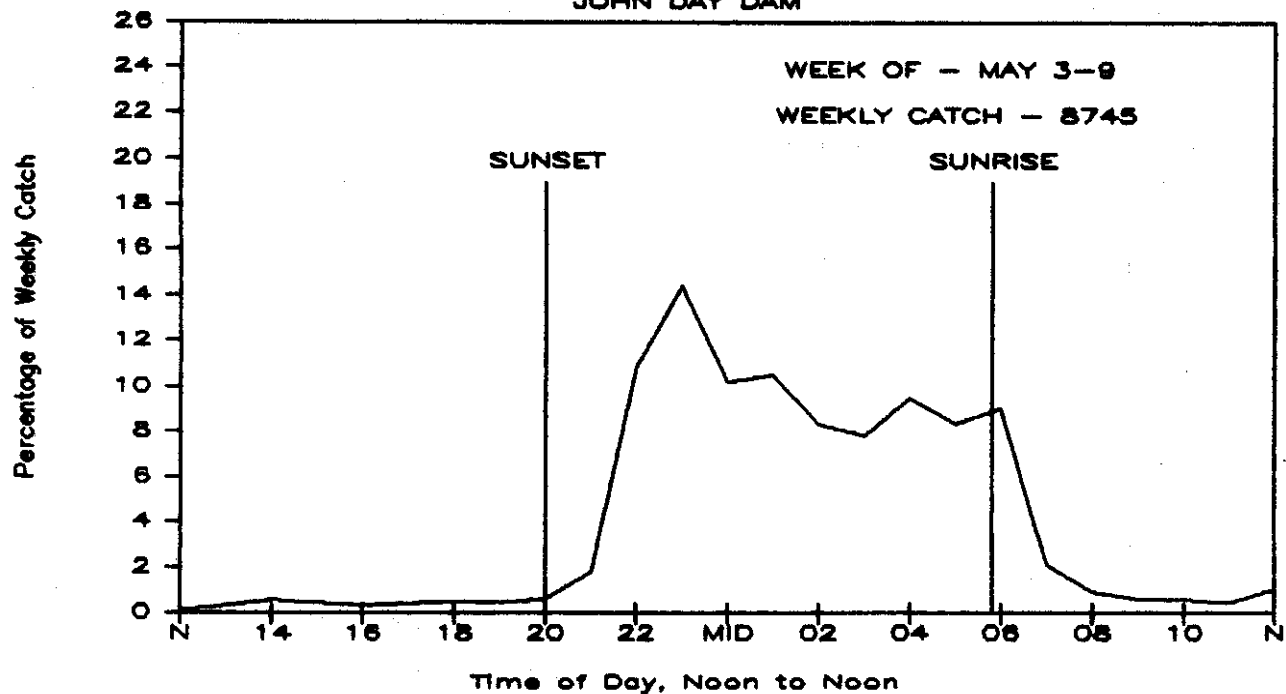


FIGURE 4

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

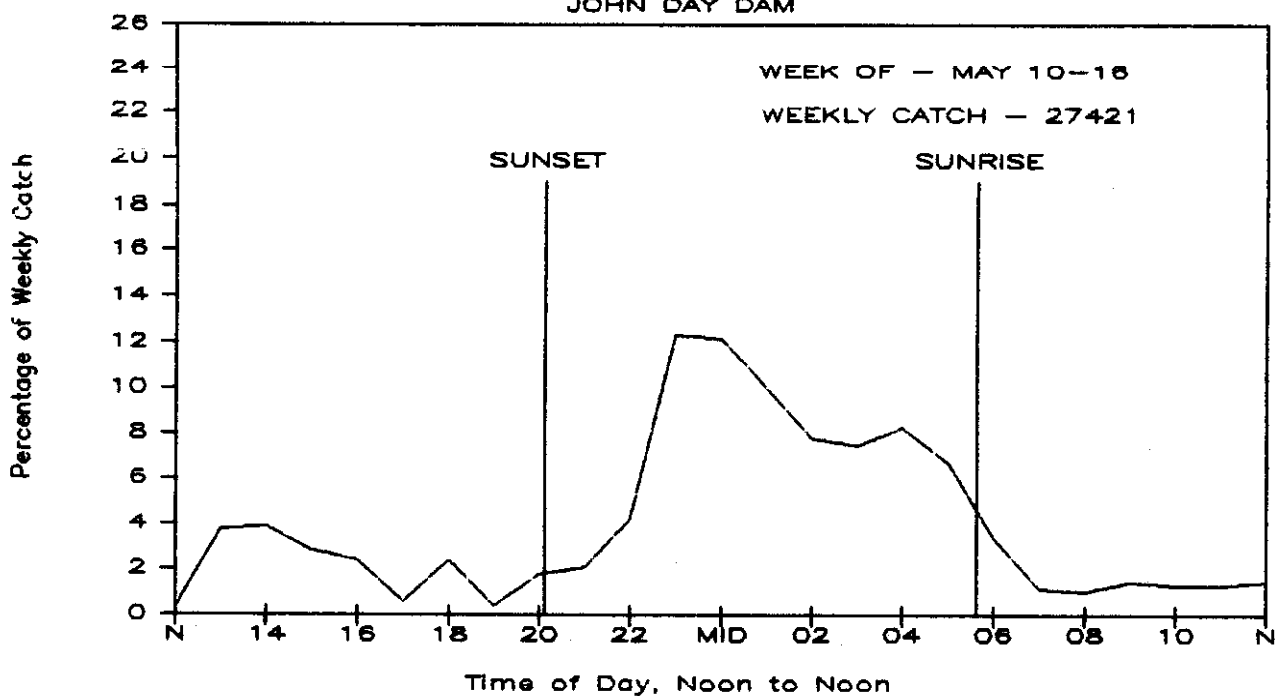


FIGURE 5

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

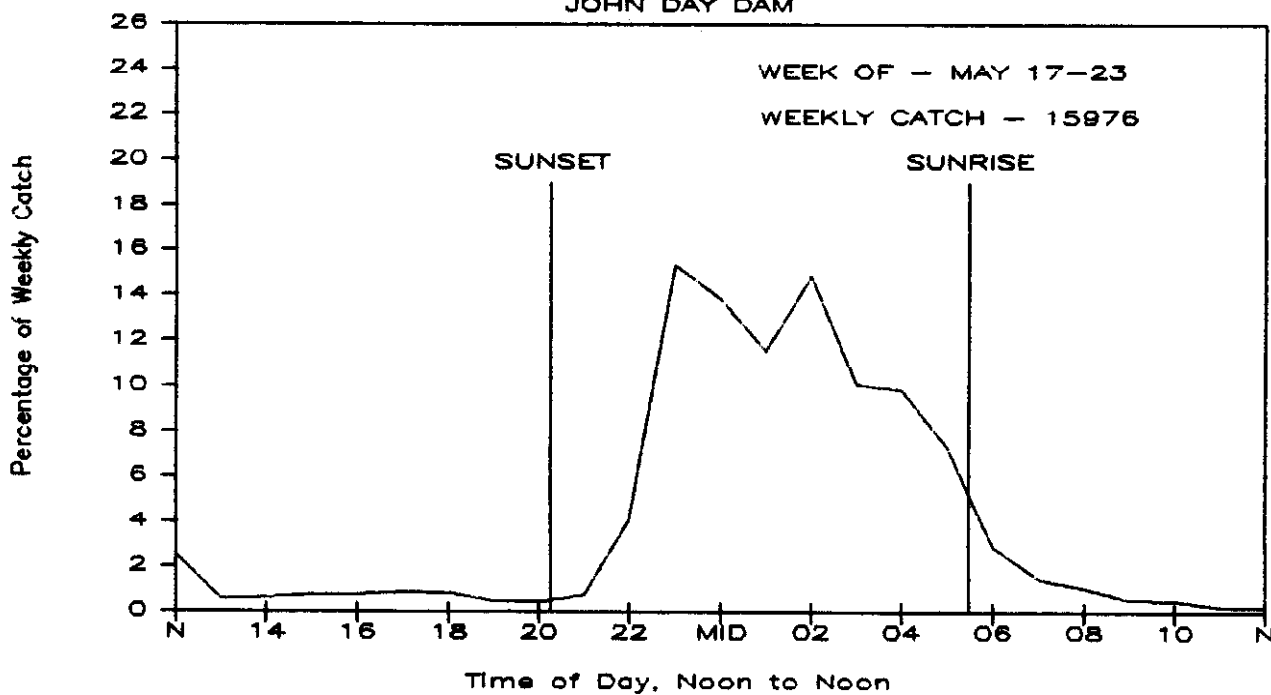


FIGURE 6

WEEKLY DIEL PATTERN, CHINOOK 1's JOHN DAY DAM

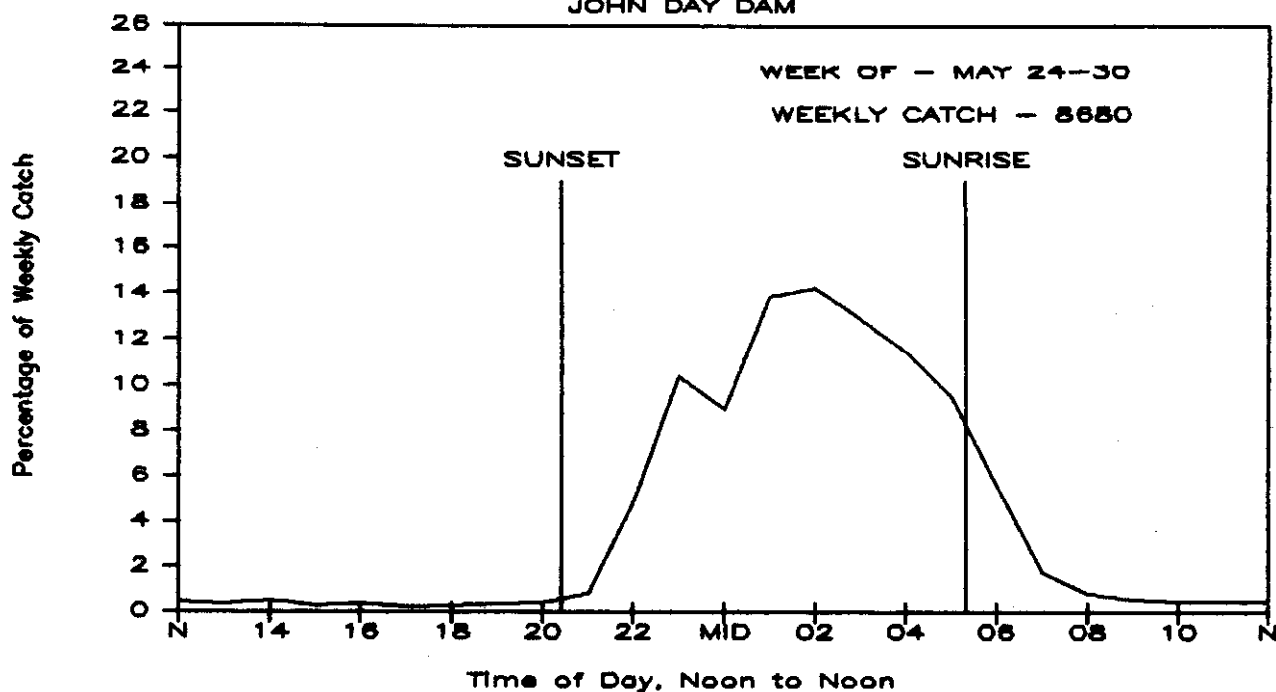


FIGURE 7

WEEKLY DIEL PATTERN, CHINOOK 1's JOHN DAY DAM

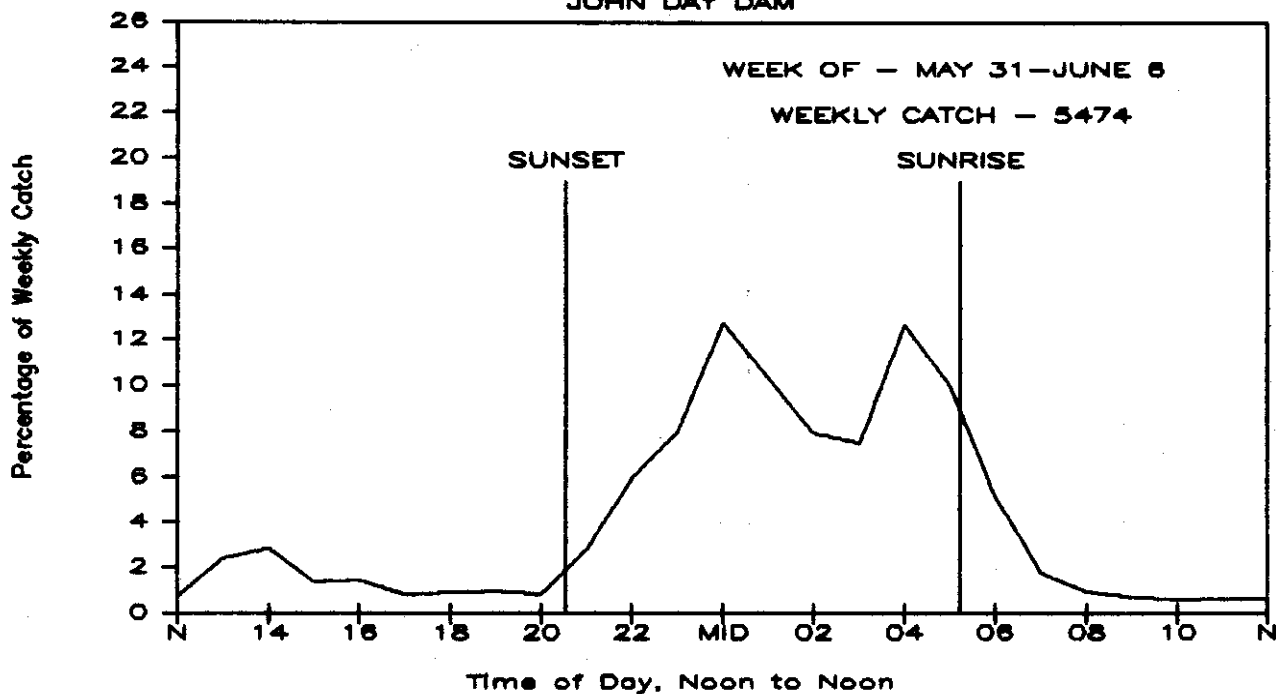


FIGURE 8

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

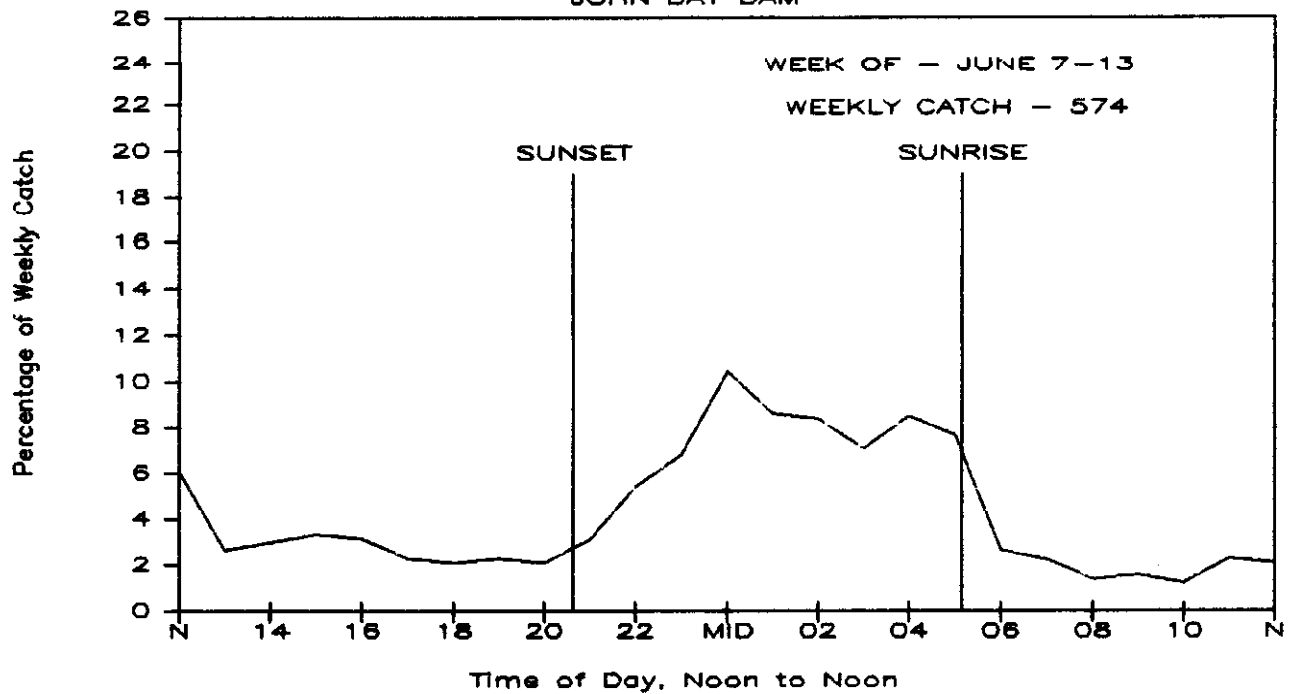


FIGURE 9

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

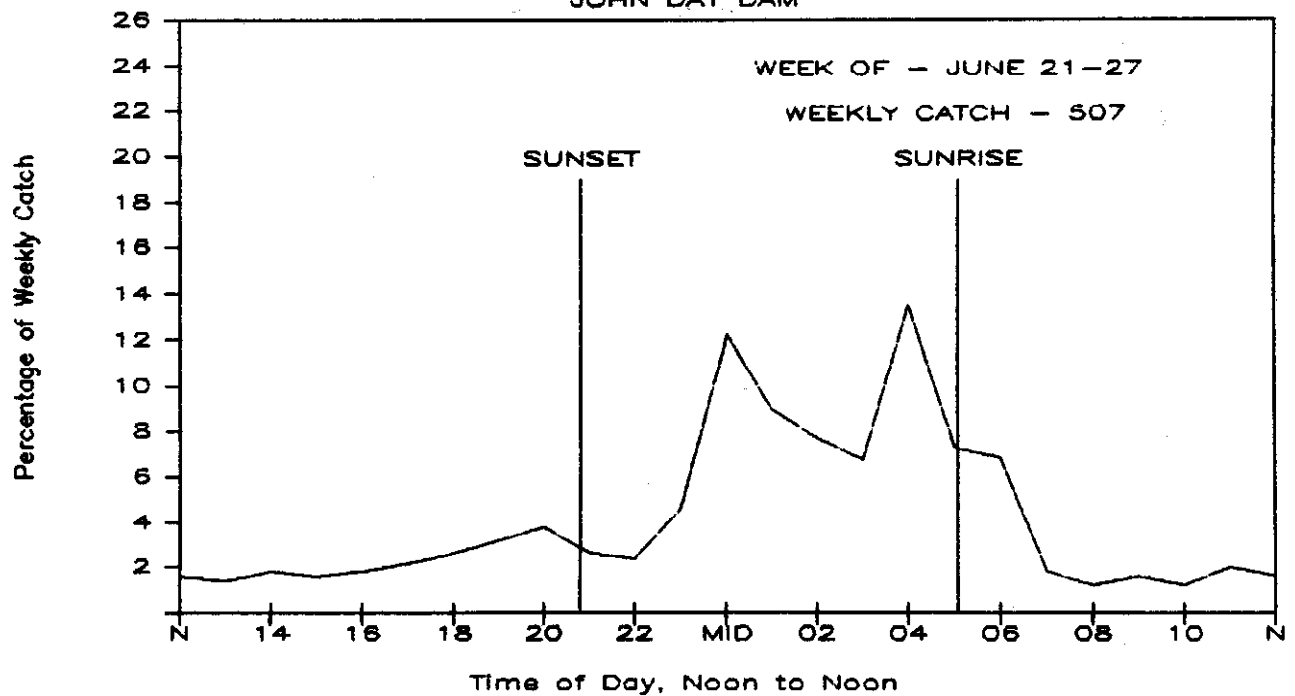


FIGURE 10

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

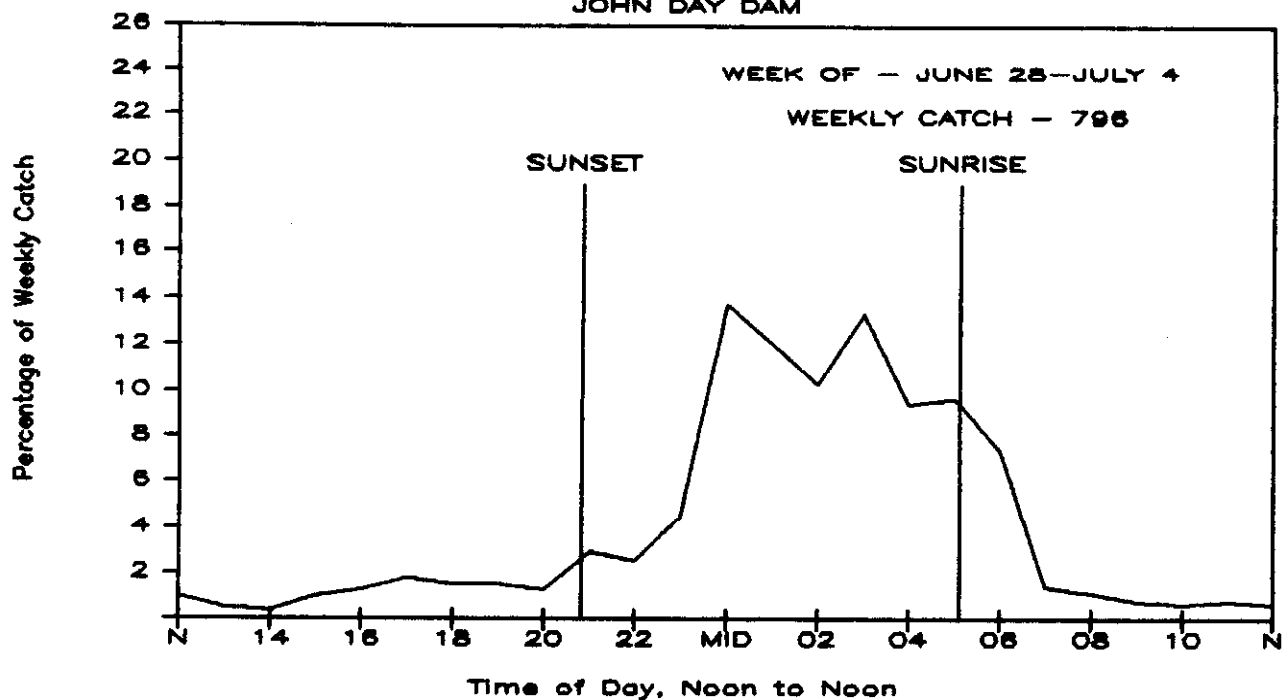


FIGURE 11

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

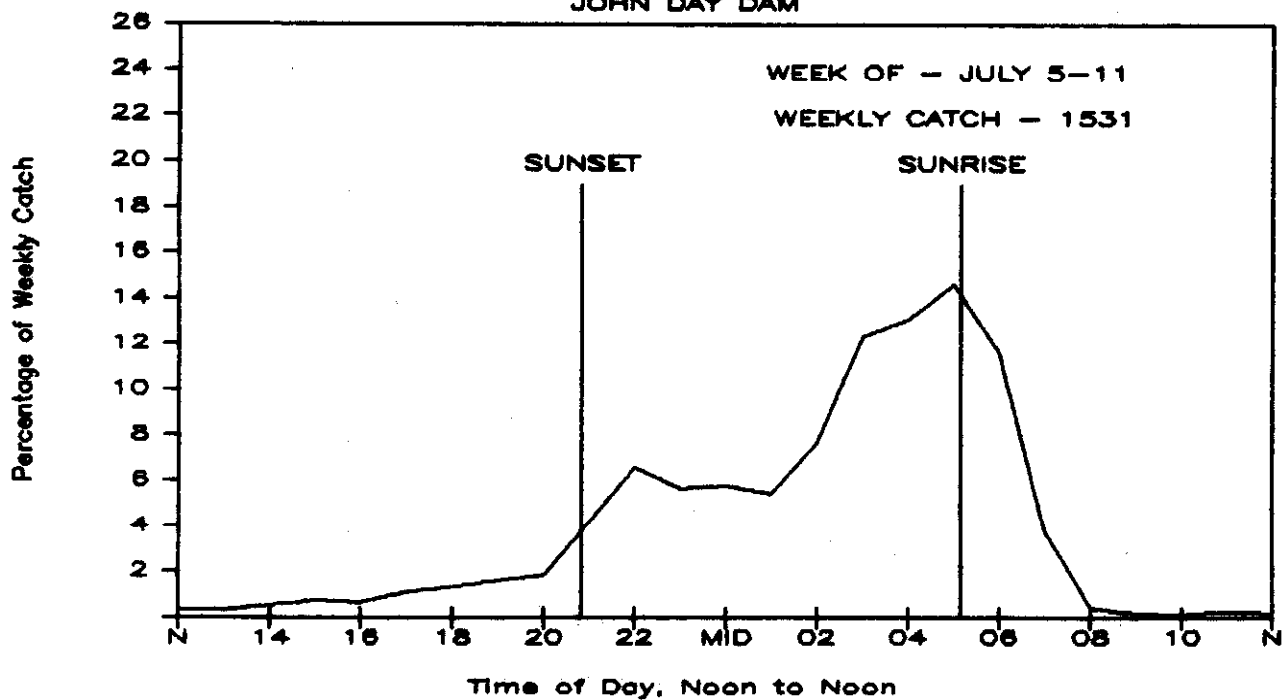


FIGURE 12

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

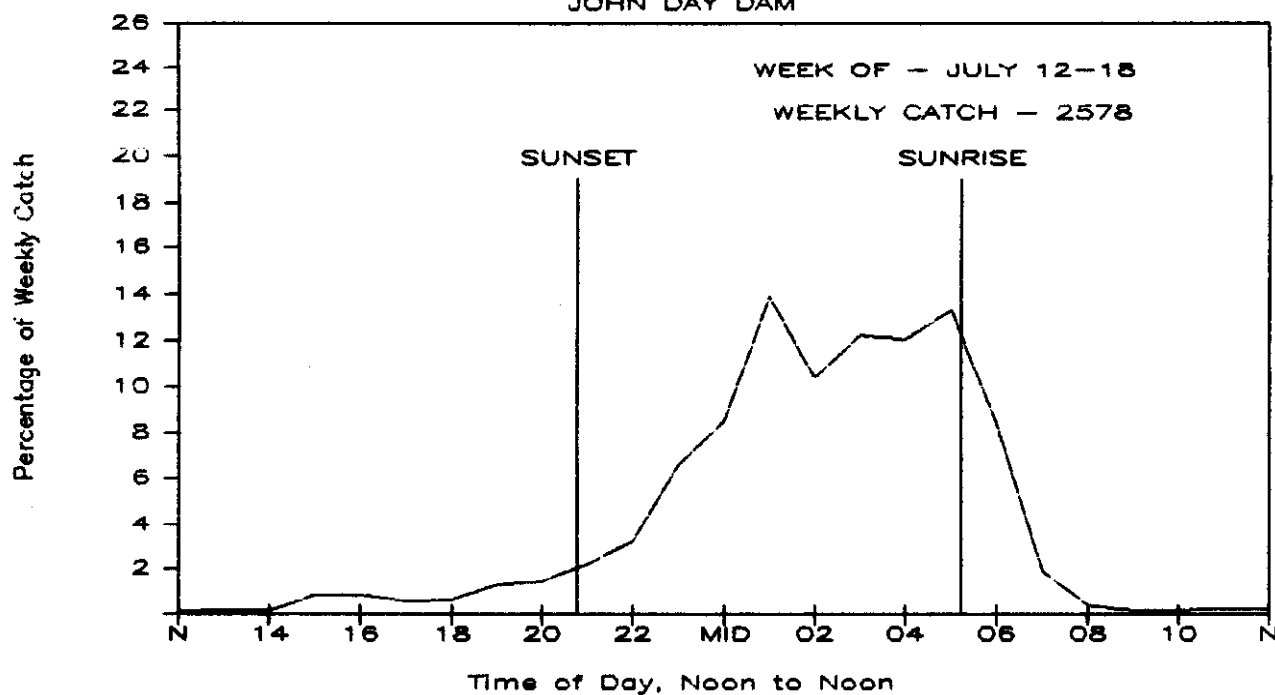


FIGURE 13

WEEKLY DIEL PATTERN, CHINOOK 1's

JOHN DAY DAM

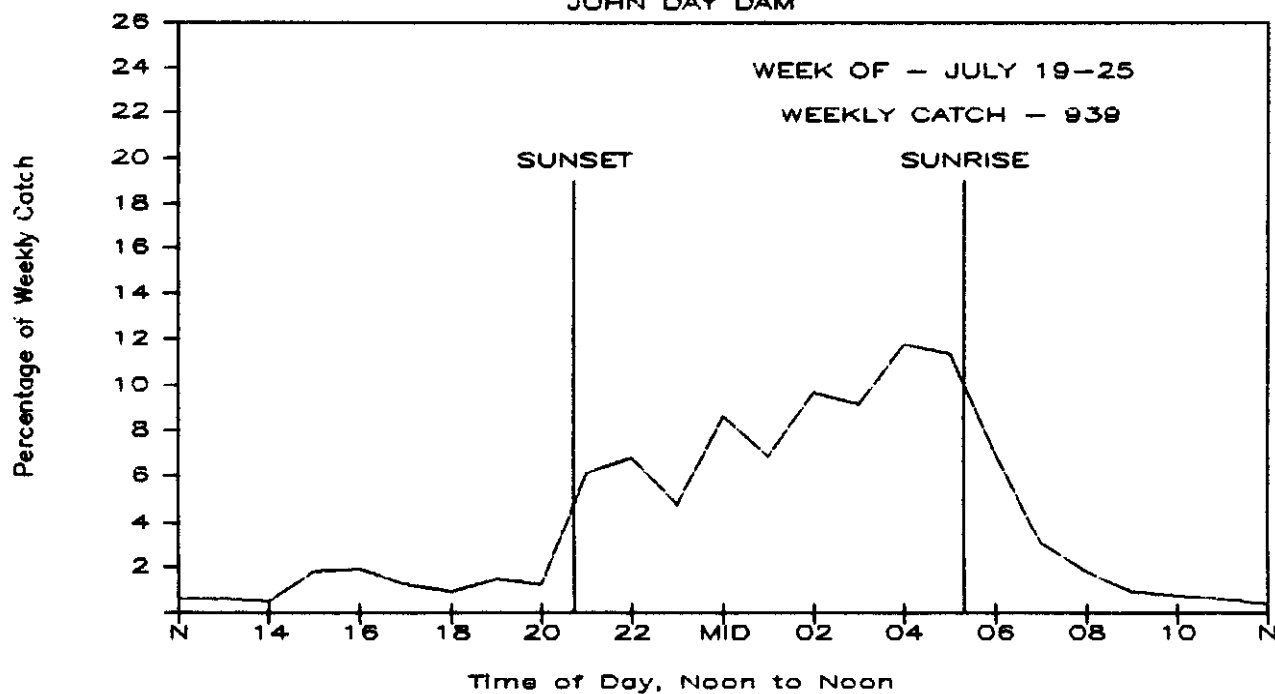


FIGURE 14

WEEKLY DIEL PATTERN, CHINOOK 1's JOHN DAY DAM

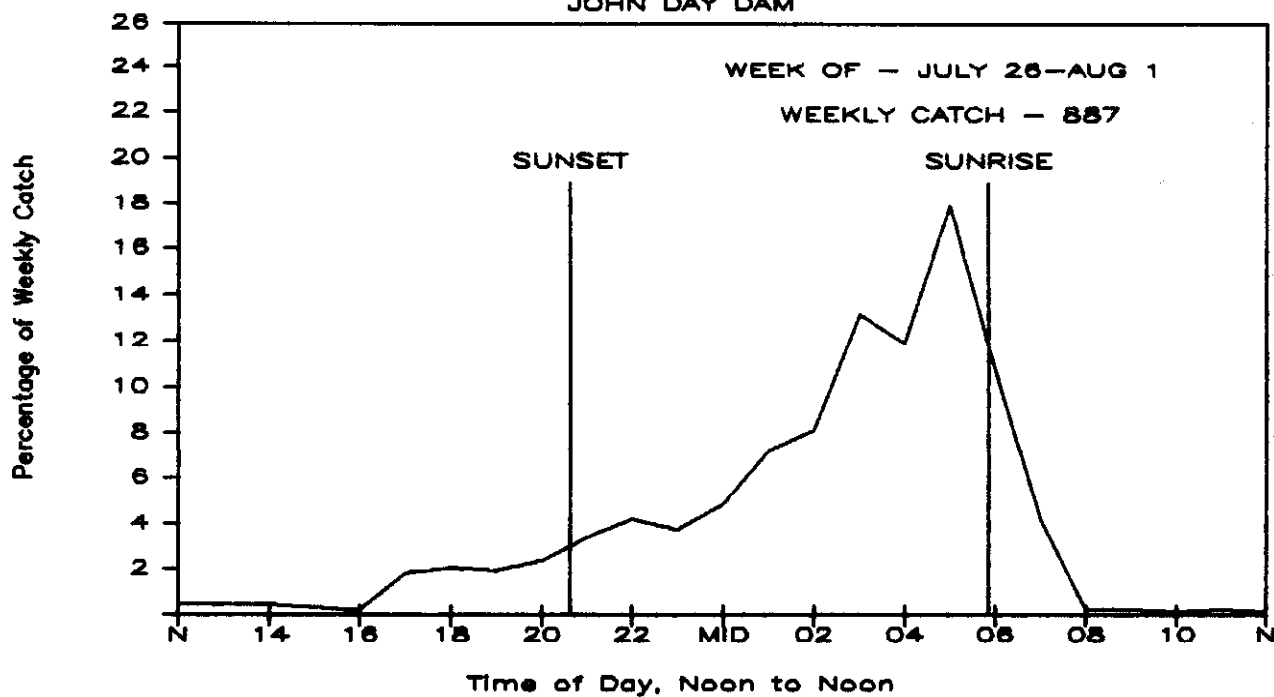


FIGURE 15

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

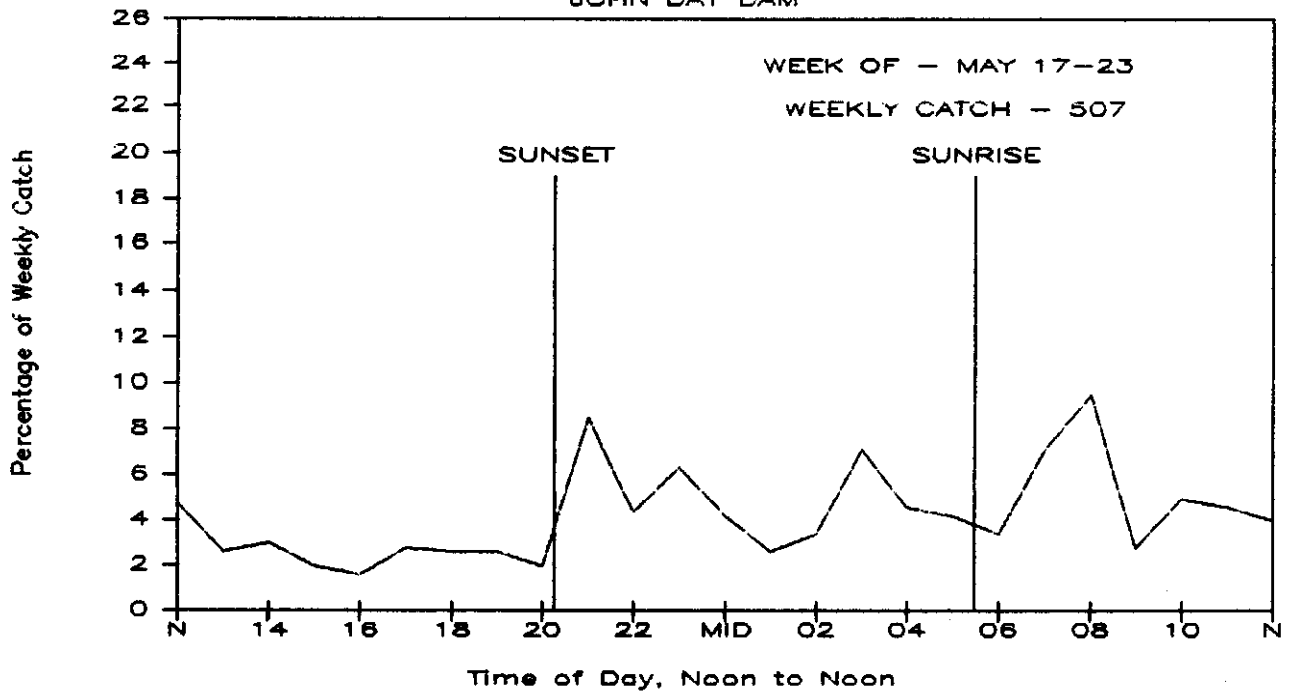


FIGURE 16

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

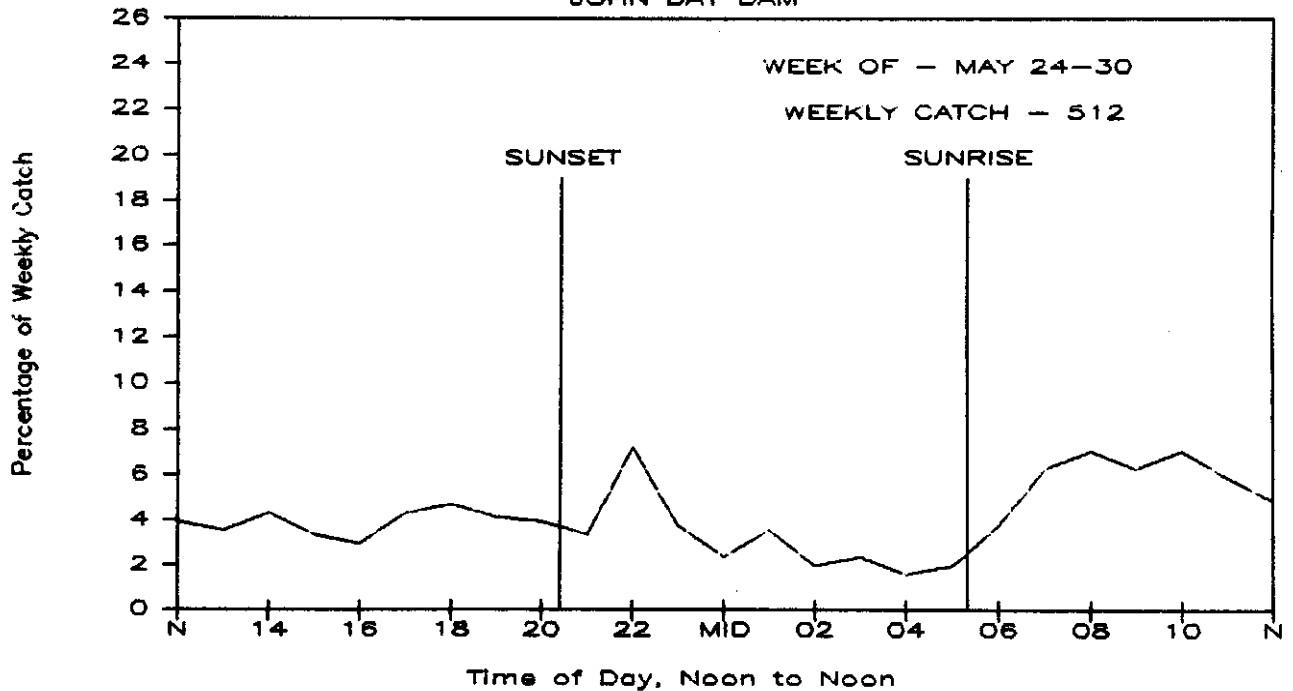


FIGURE 17

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

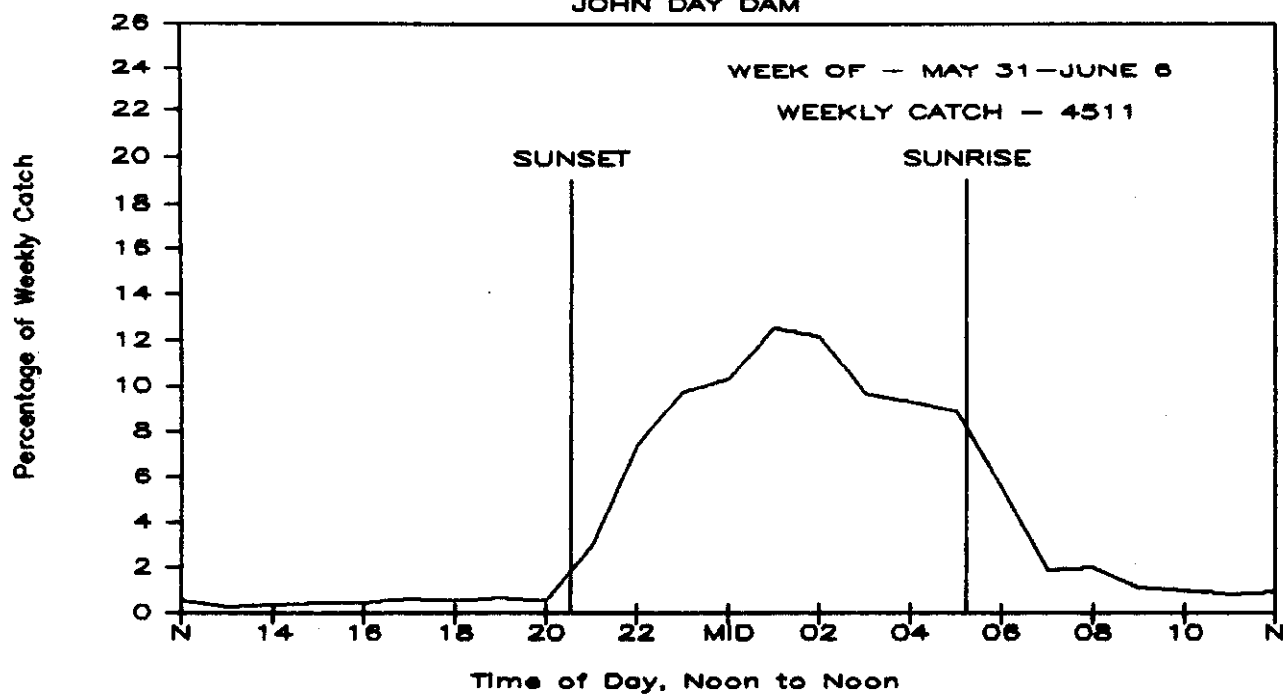


FIGURE 18

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

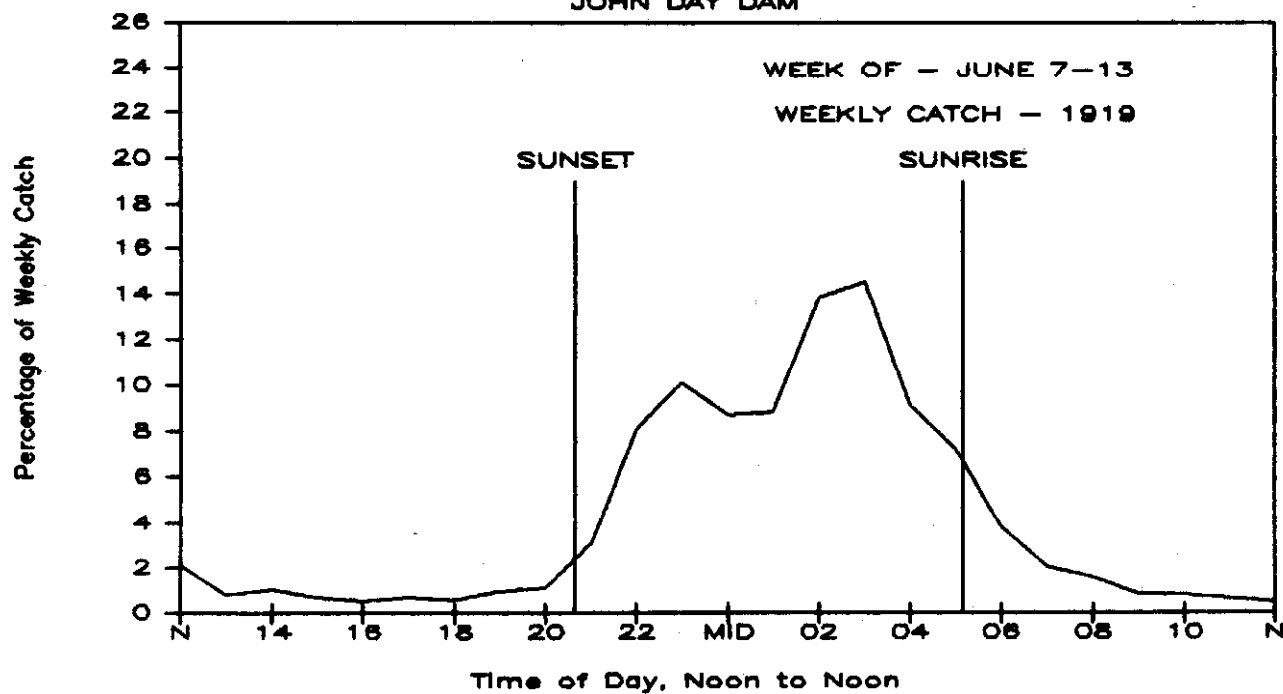


FIGURE 19

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

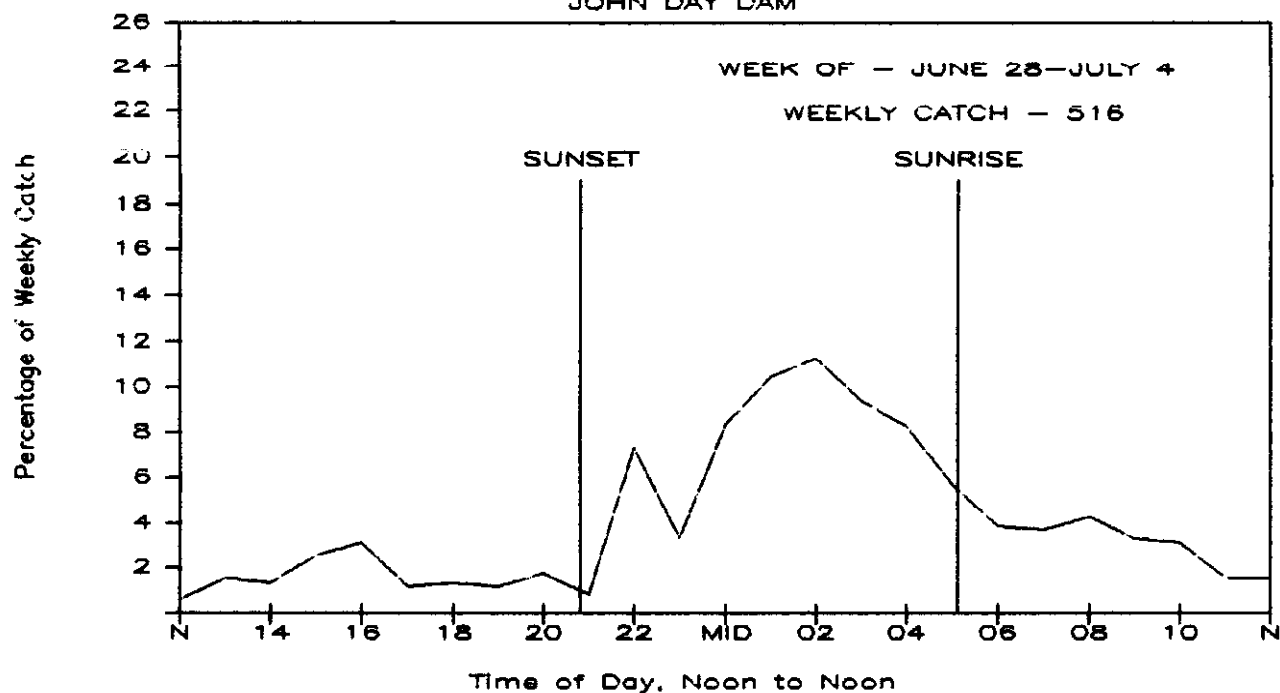


FIGURE 20

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

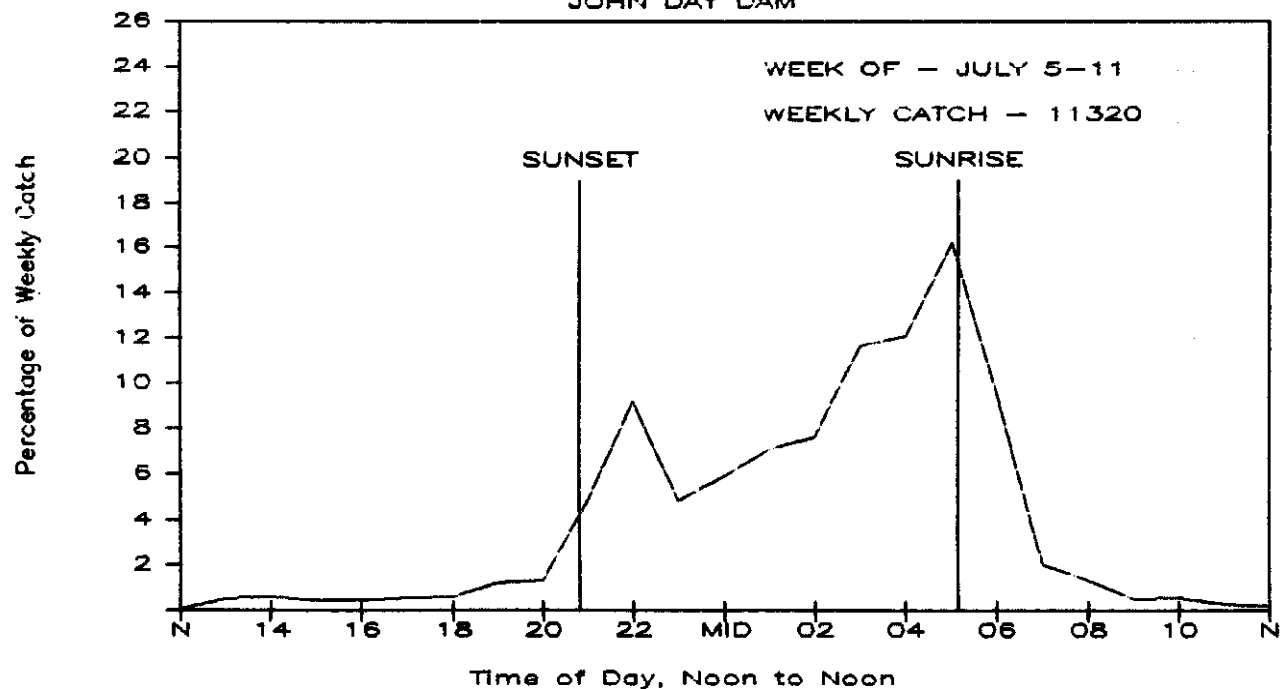


FIGURE 21

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

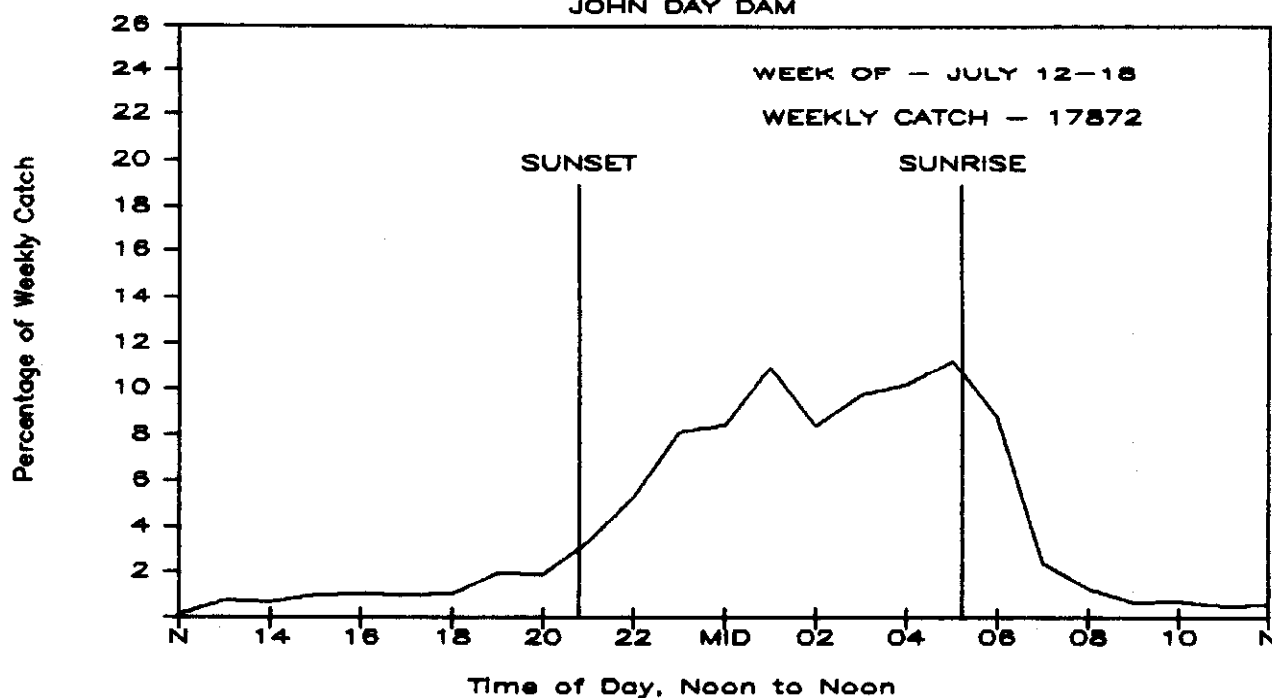


FIGURE 24

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

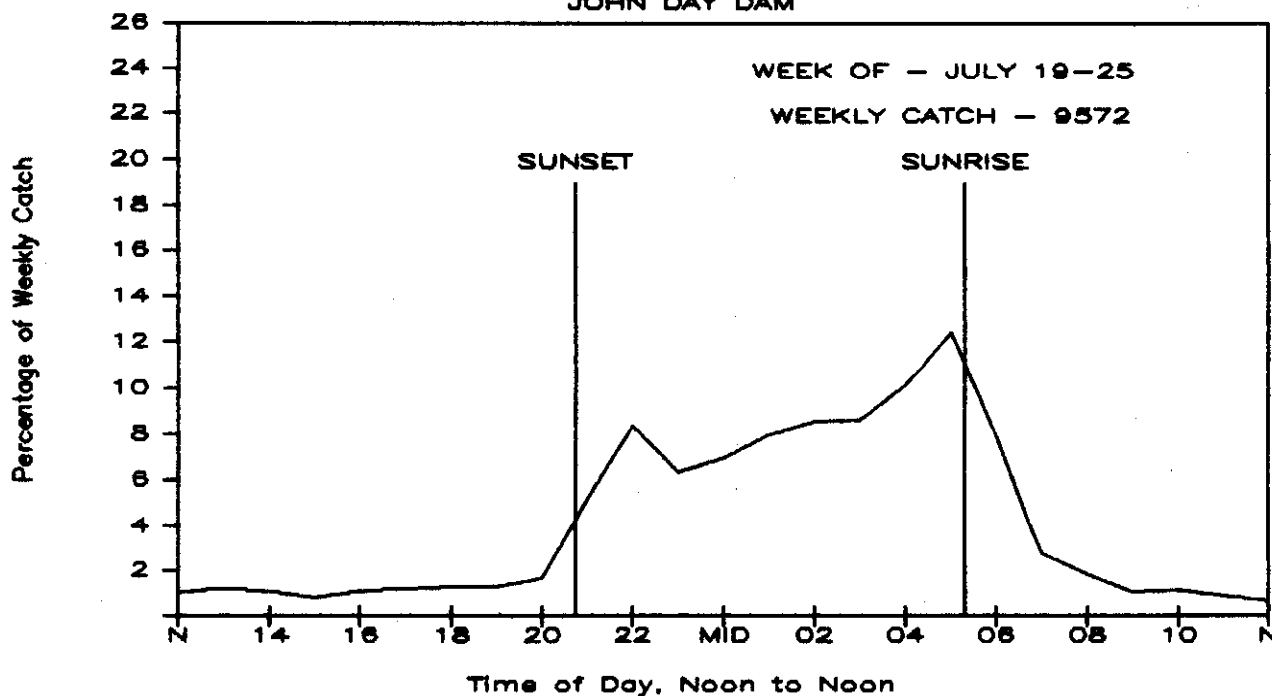


FIGURE 25

WEEKLY DIEL PATTERN, CHINOOK 0's JOHN DAY DAM

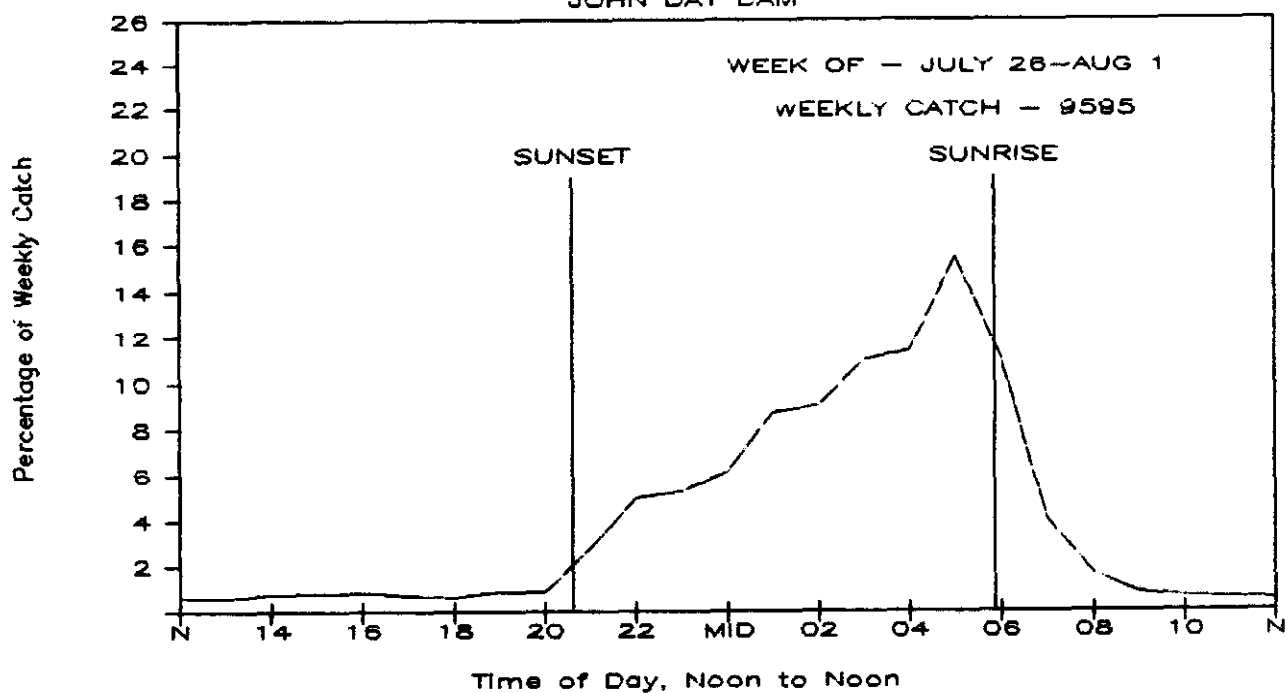


FIGURE 24

WEEKLY DIEL PATTERN, CHINOOK 0's JOHN DAY DAM

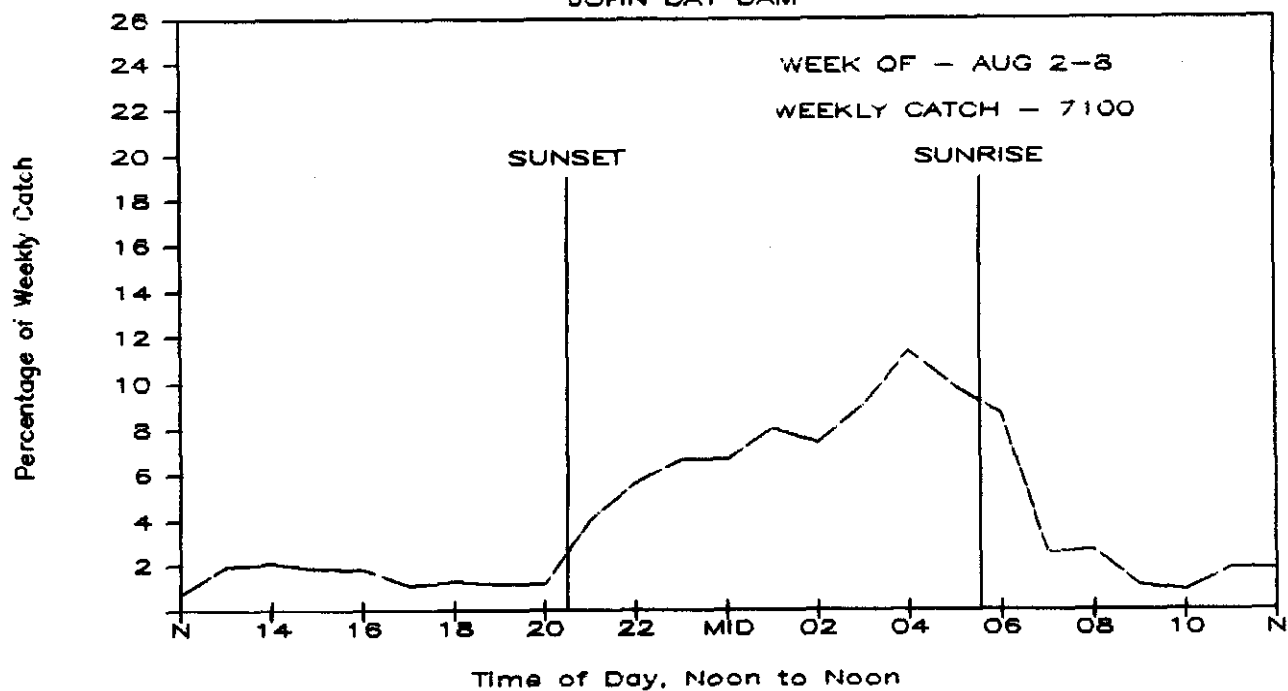


FIGURE 25

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

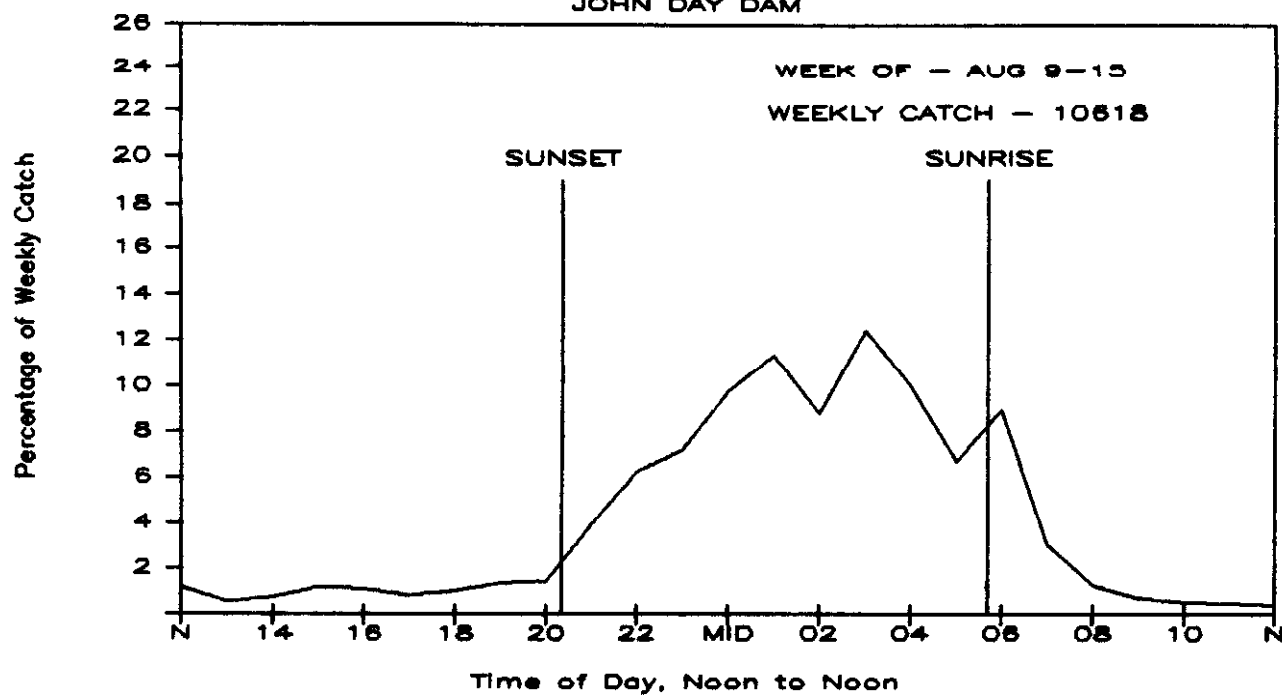


FIGURE 26

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

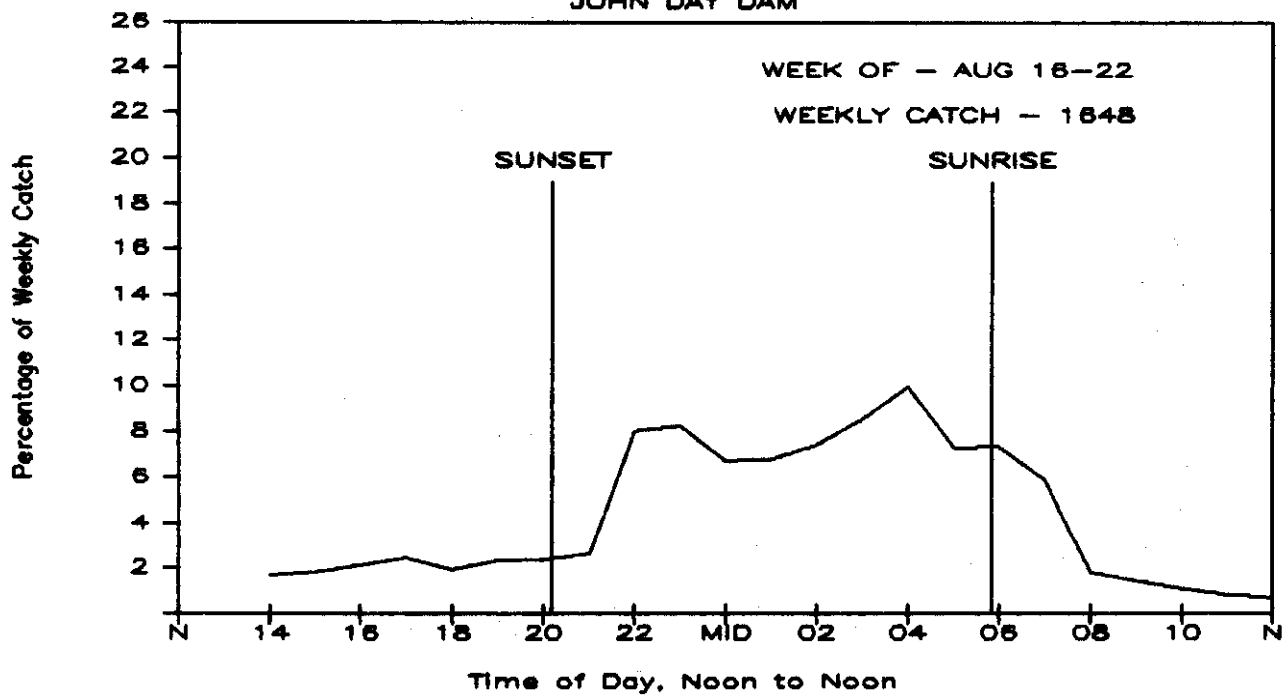


FIGURE 27

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

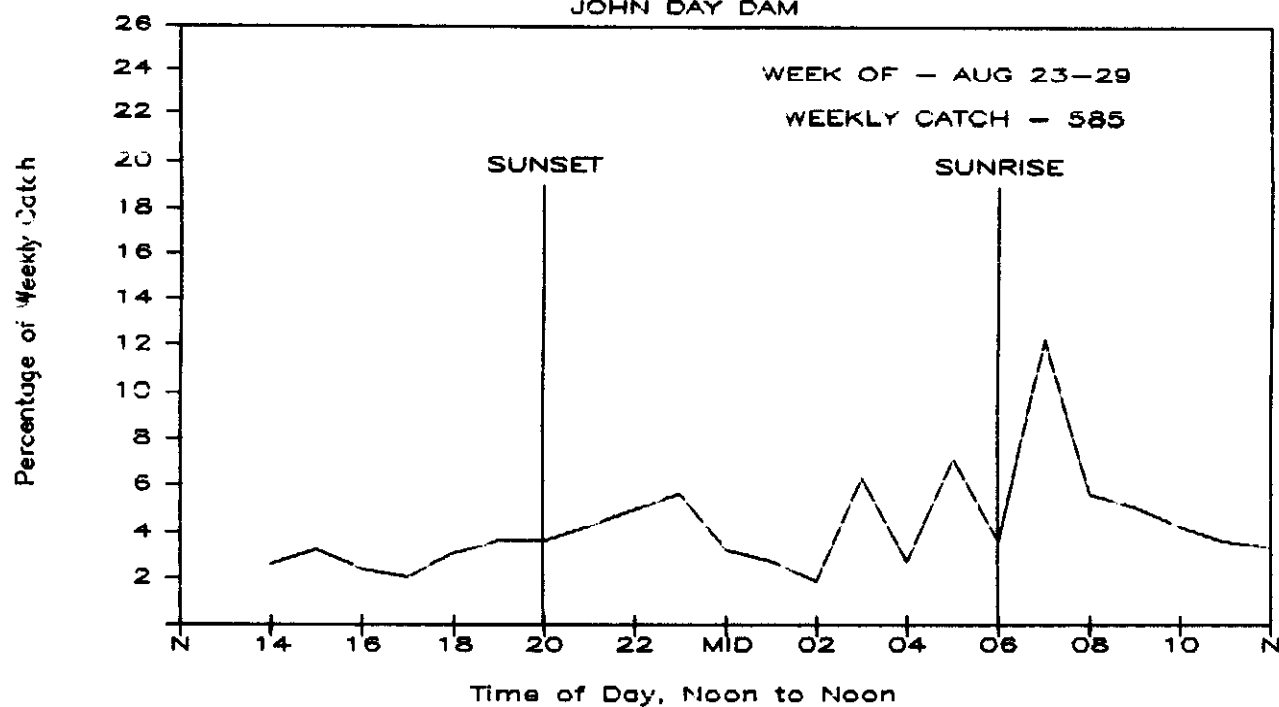


FIGURE 28

WEEKLY DIEL PATTERN, CHINOOK 0's

JOHN DAY DAM

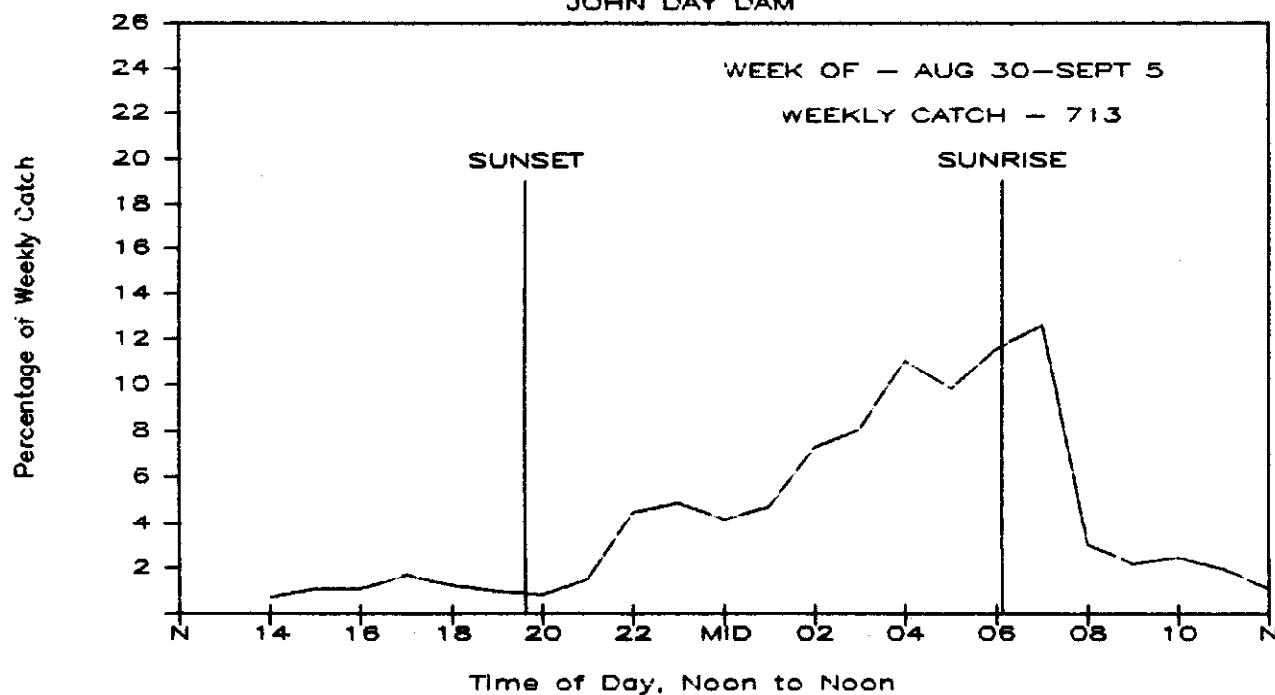


FIGURE 29

WEEKLY DIEL PATTERN, CHINOOK 0's JOHN DAY DAM

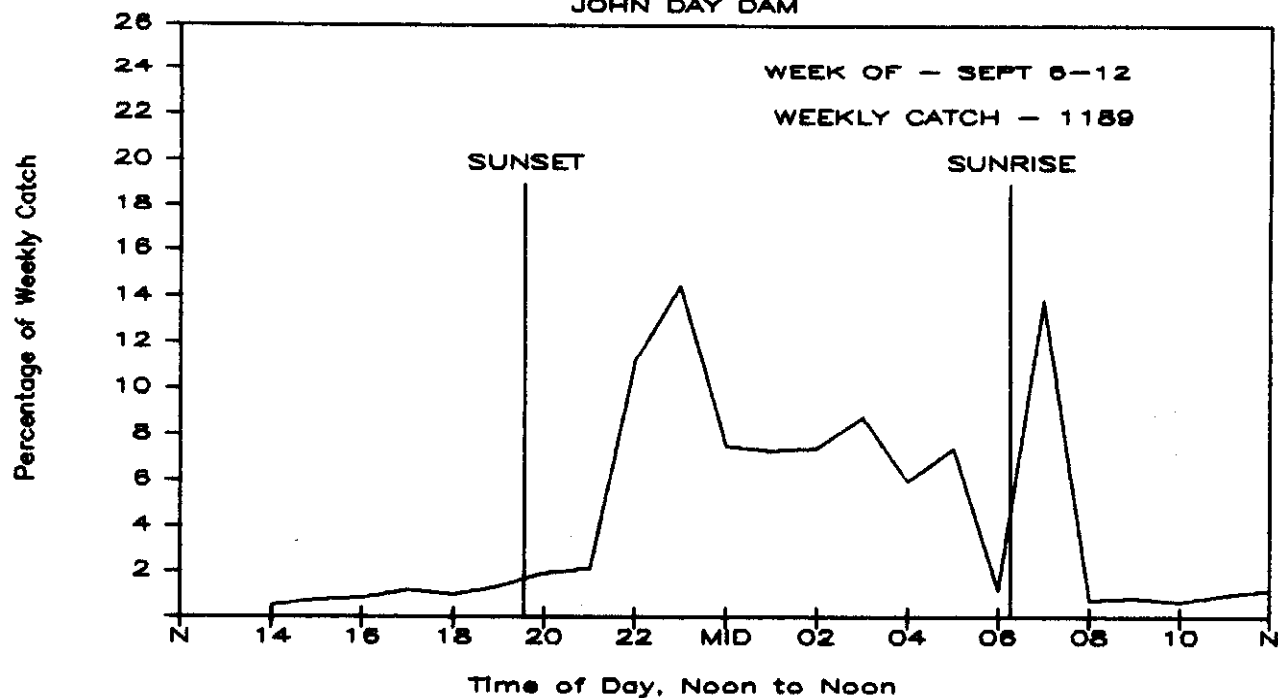


FIGURE 30

WEEKLY DIEL PATTERN, CHINOOK 0's JOHN DAY DAM

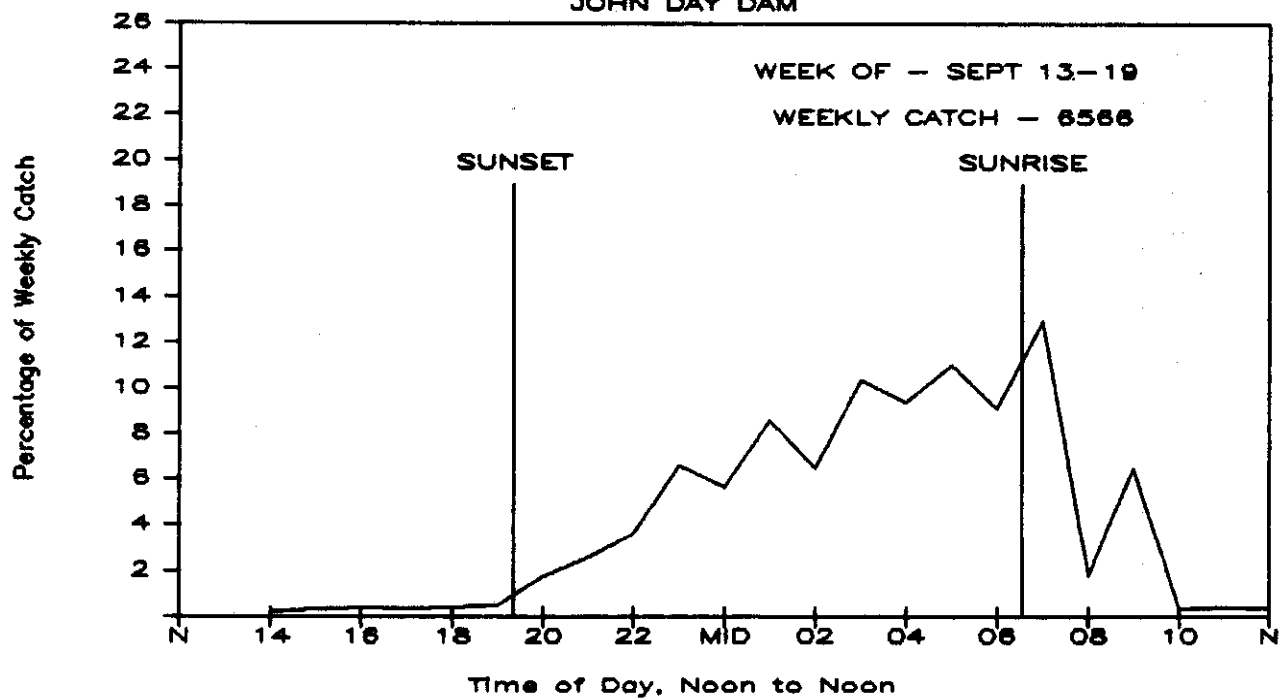


FIGURE 31

WEEKLY DIEL PATTERN, CHINOOK 0's JOHN DAY DAM

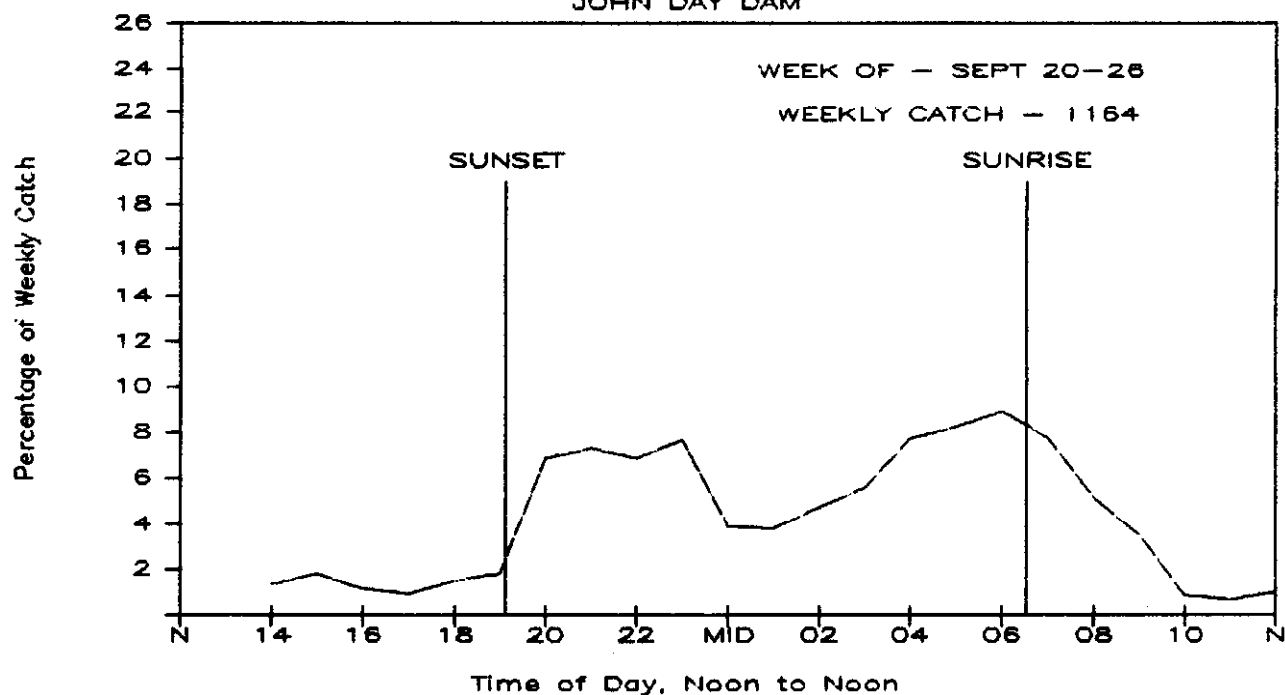


FIGURE 32

WEEKLY DIEL PATTERN, CHINOOK 0's JOHN DAY DAM

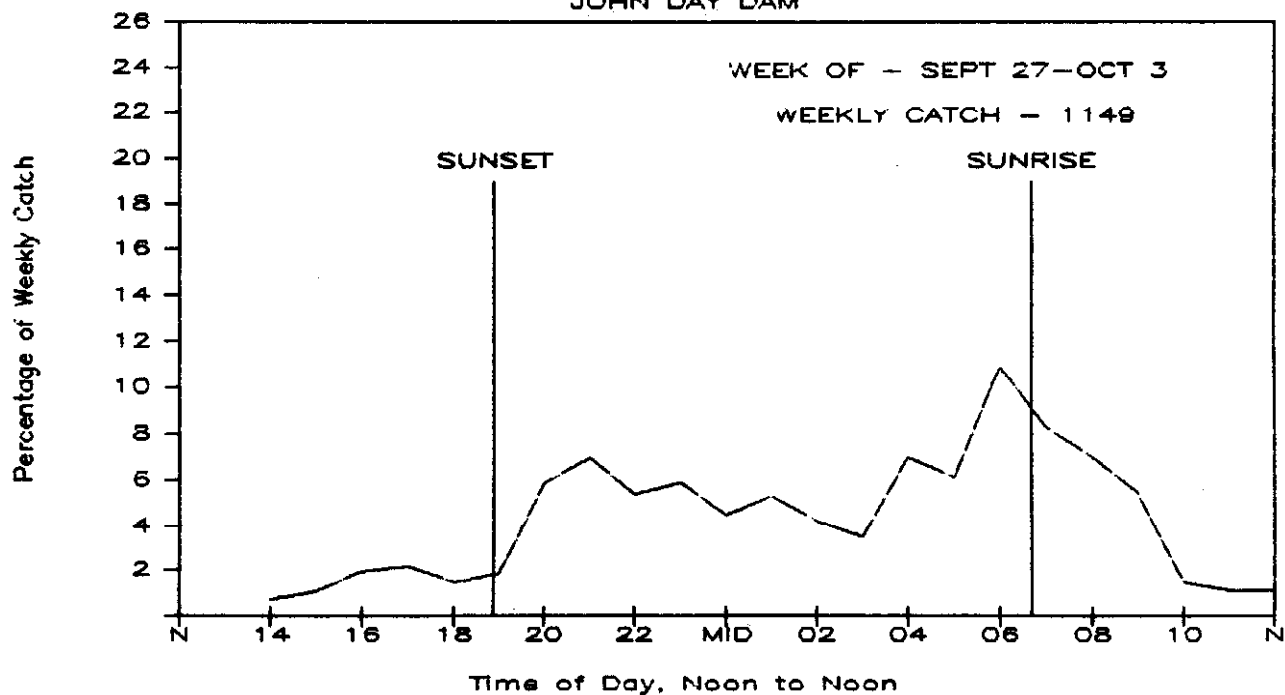


FIGURE 33

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

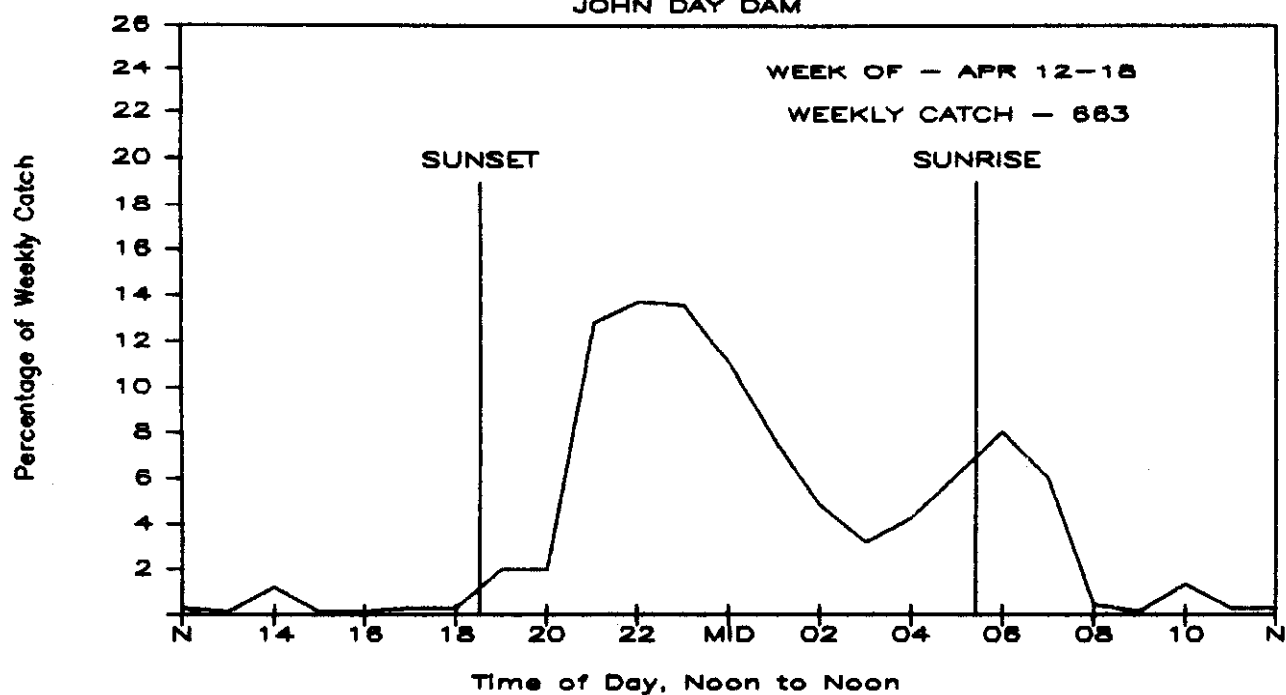


FIGURE 34

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

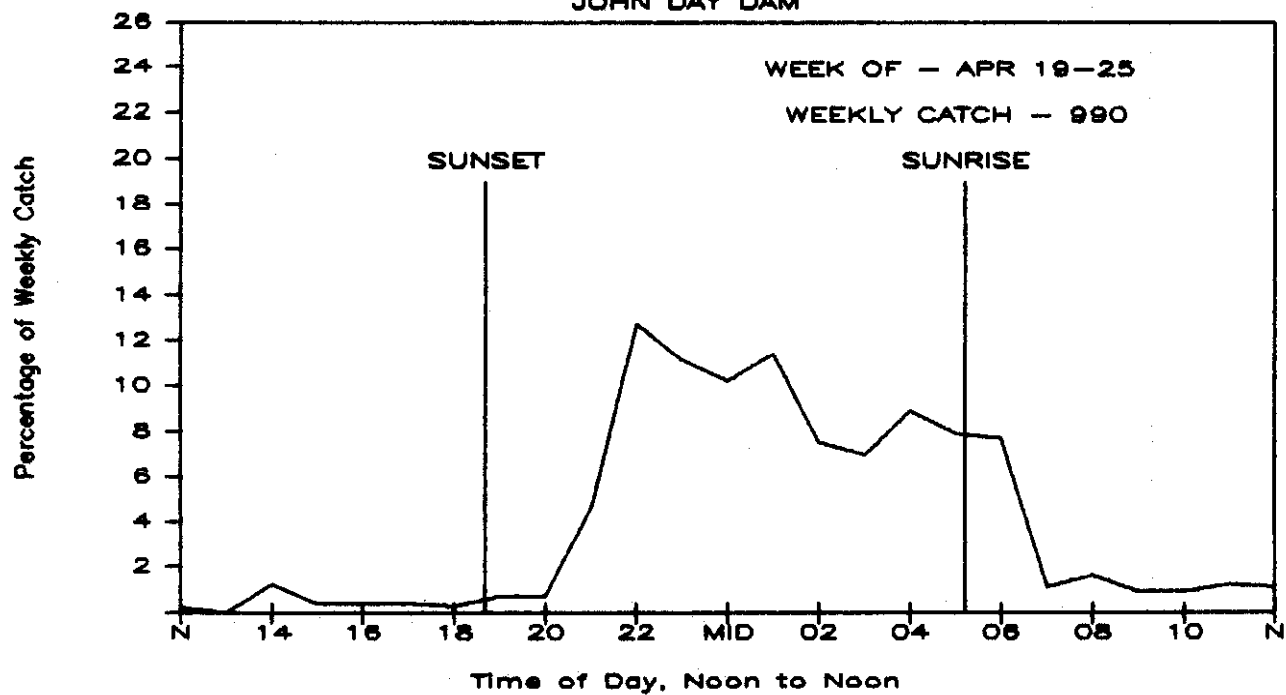


FIGURE 35

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

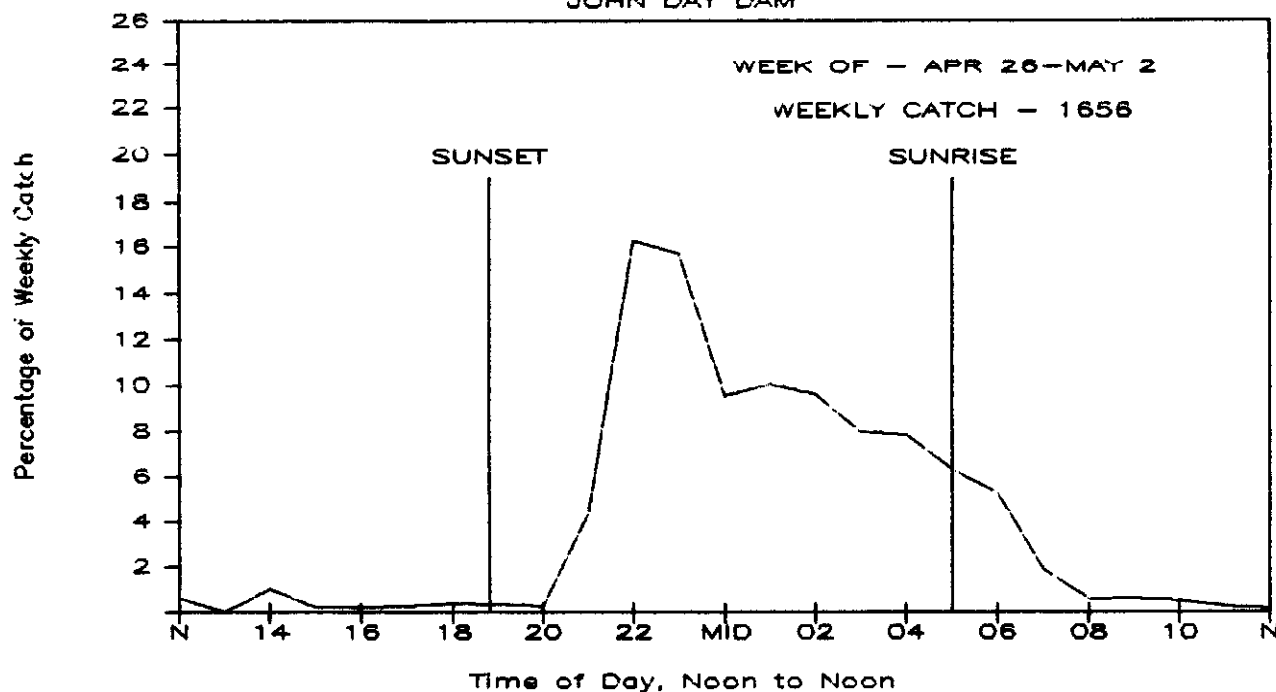


FIGURE 35

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

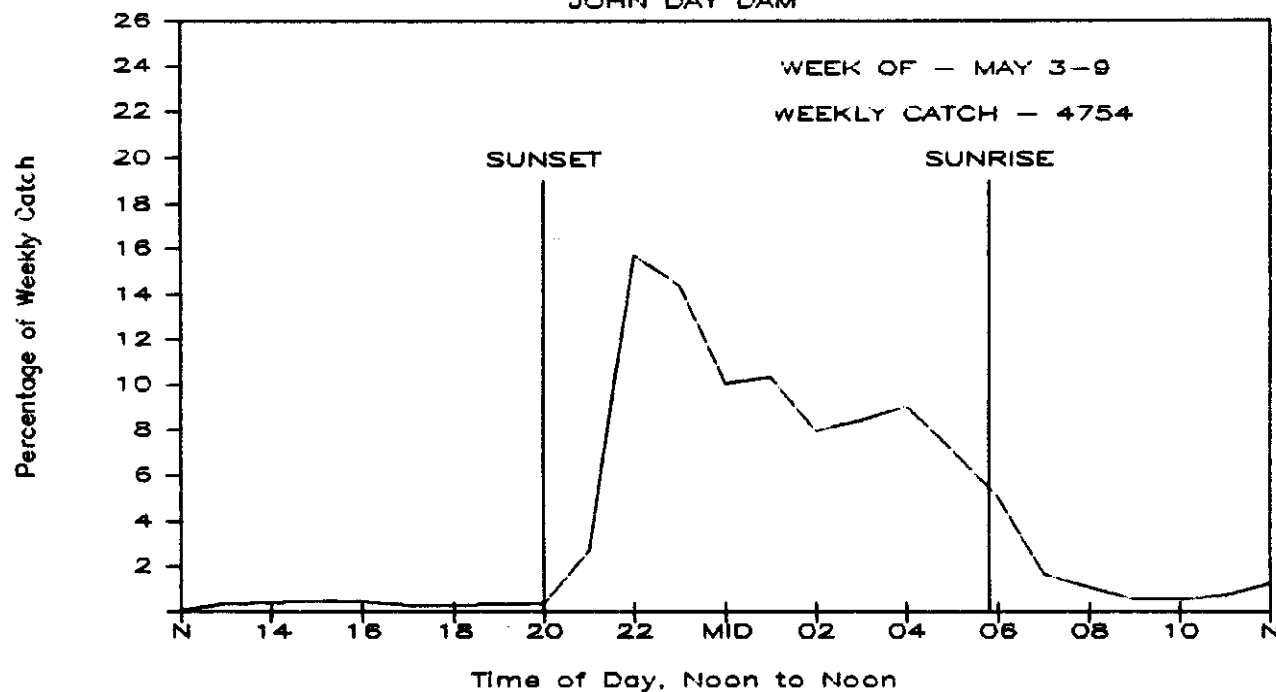


FIGURE 36

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

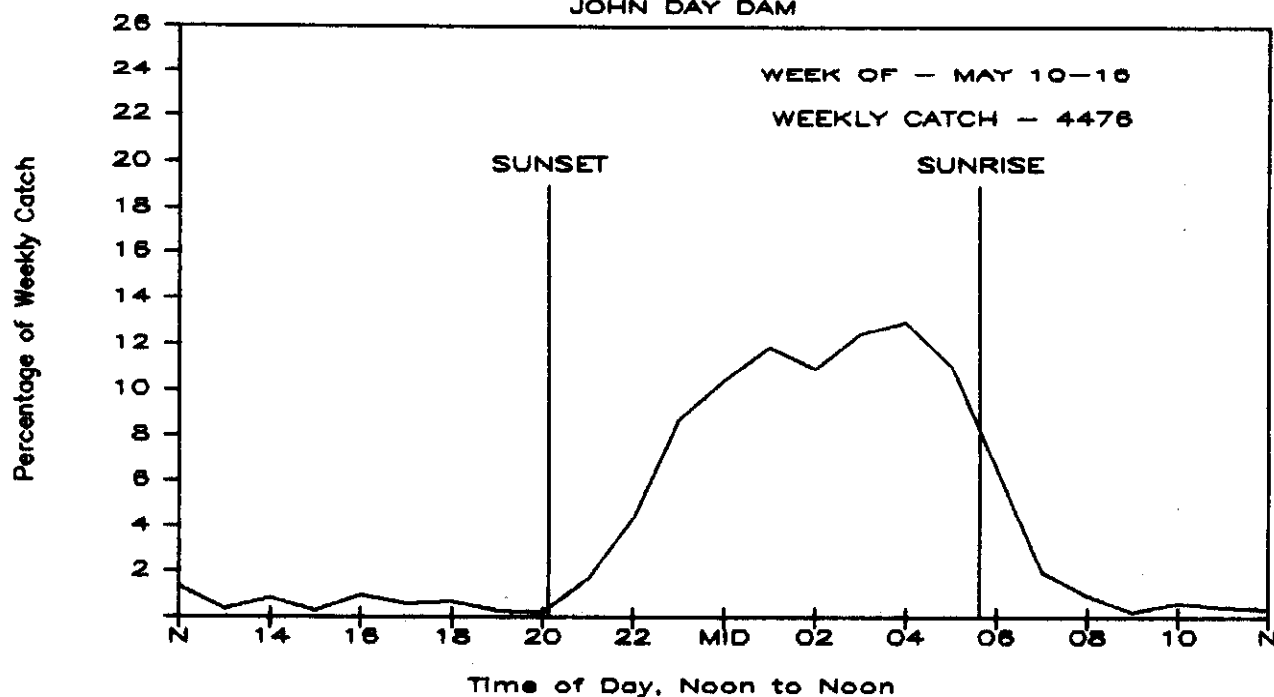


FIGURE 38

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

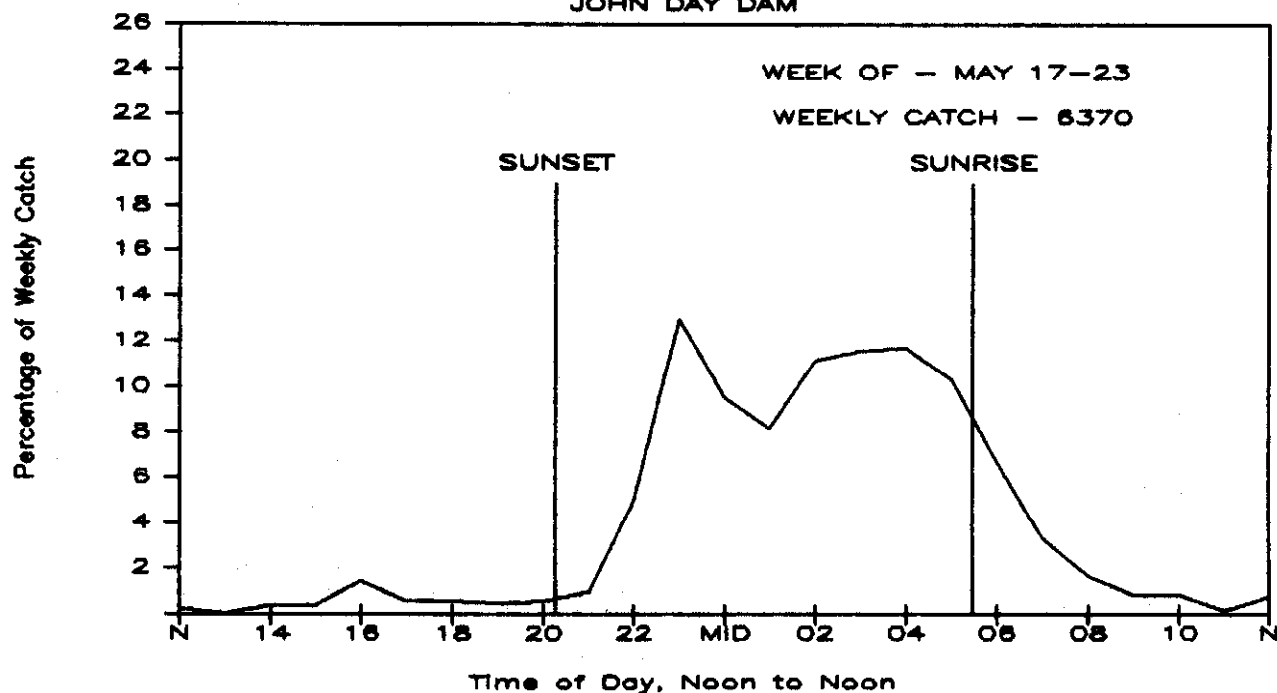


FIGURE 39

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

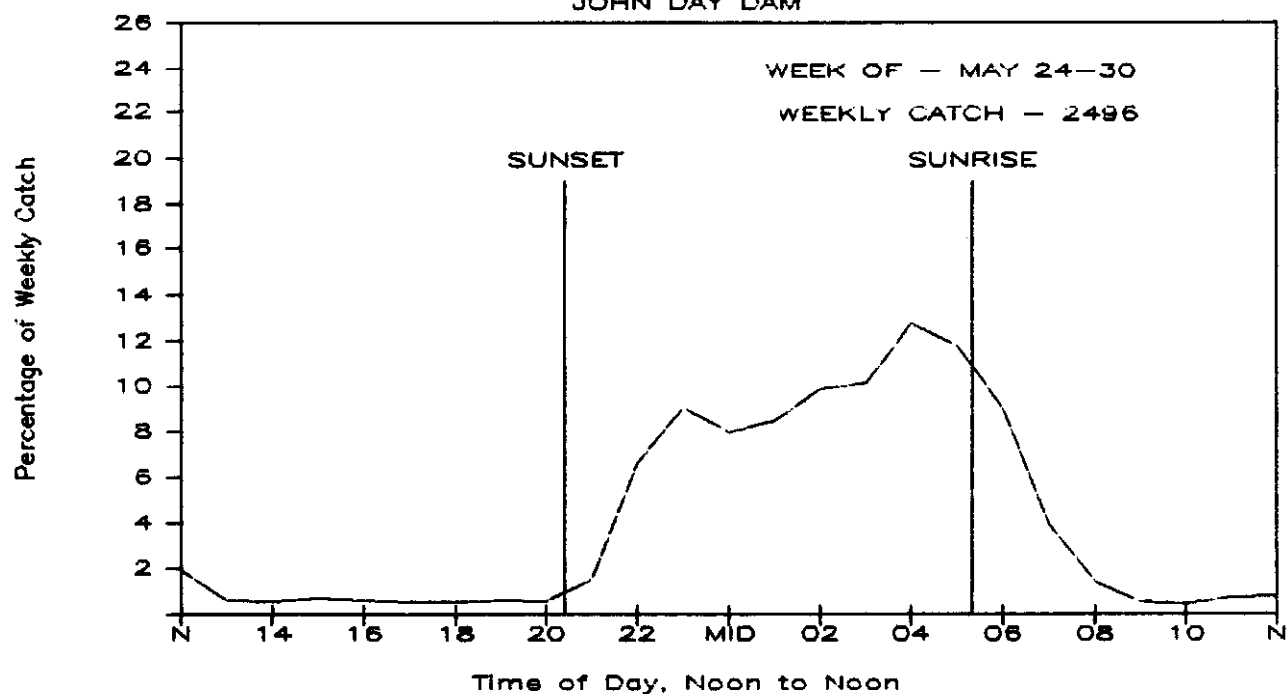


FIGURE 40

WEEKLY DIEL PATTERN, STEELHEAD

JOHN DAY DAM

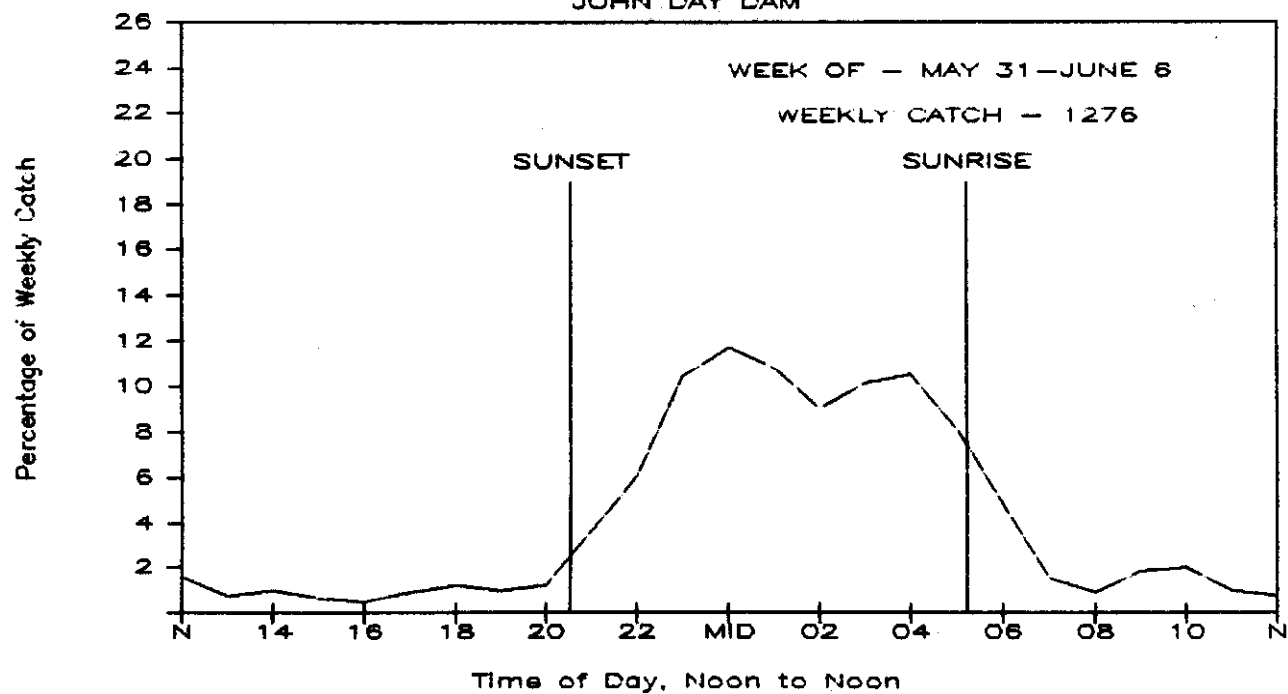


FIGURE 41

WEEKLY DIEL PATTERN, COHO

JOHN DAY DAM

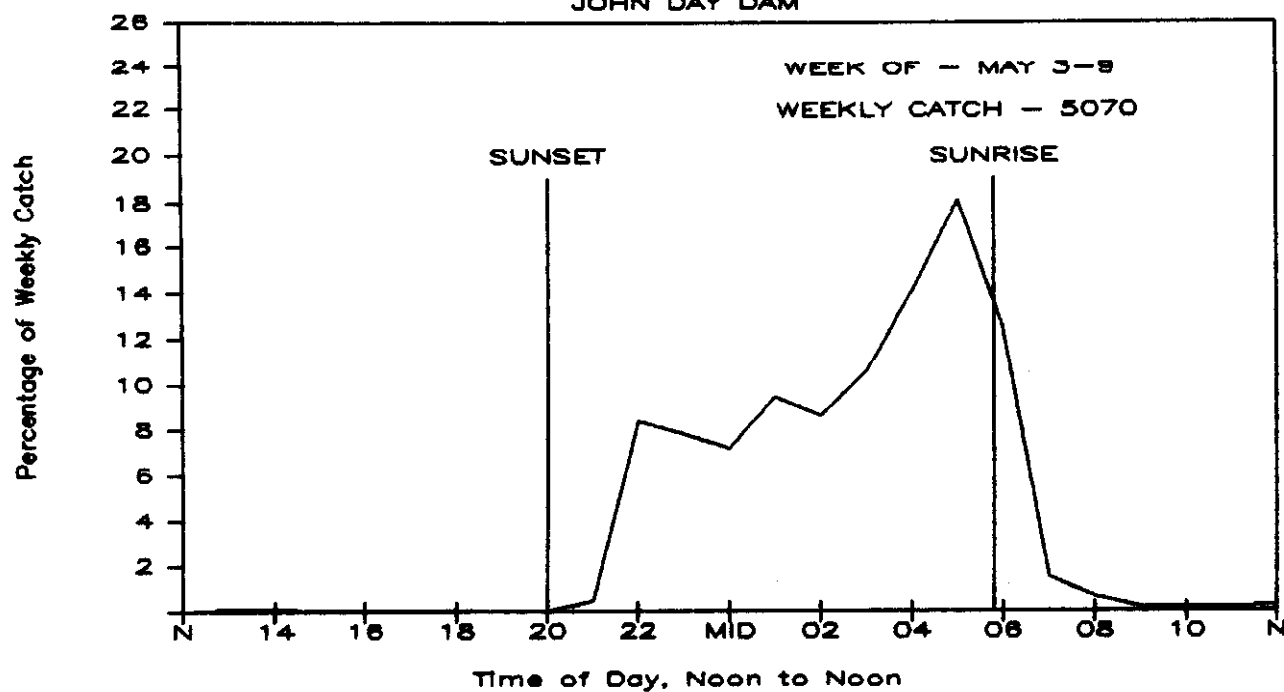


FIGURE 42

WEEKLY DIEL PATTERN, COHO

JOHN DAY DAM

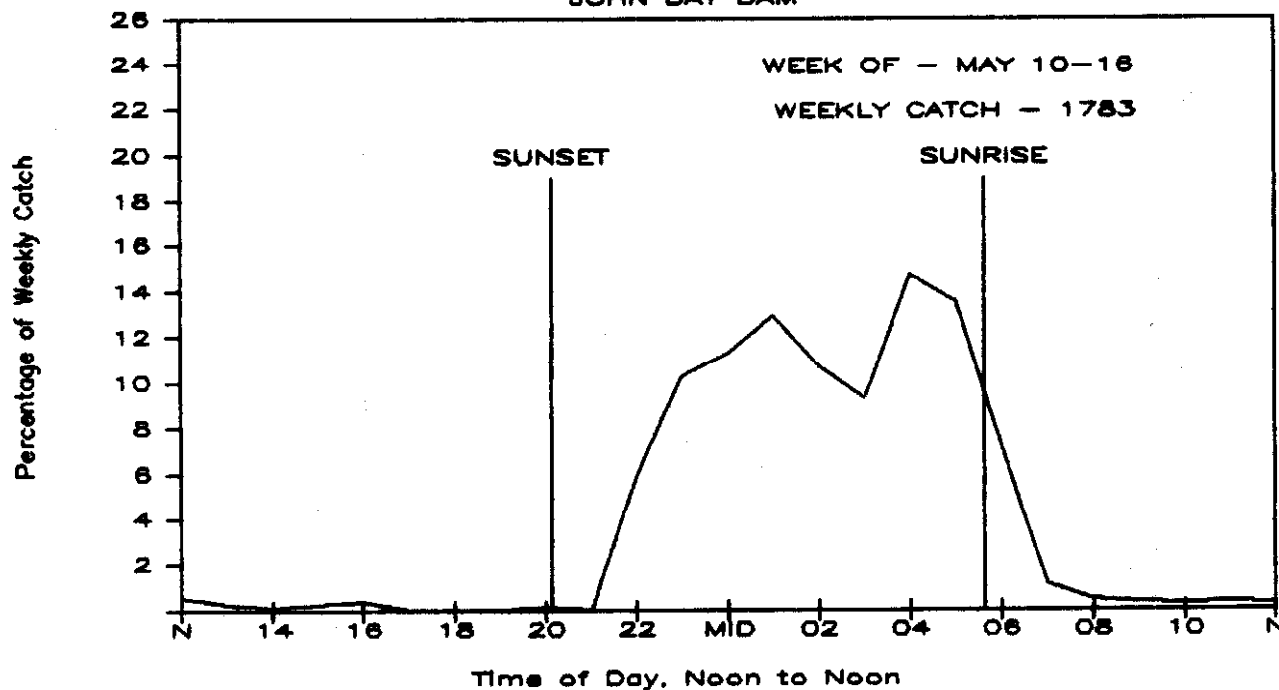


FIGURE 43

WEEKLY DIEL PATTERN, COHO

JOHN DAY DAM

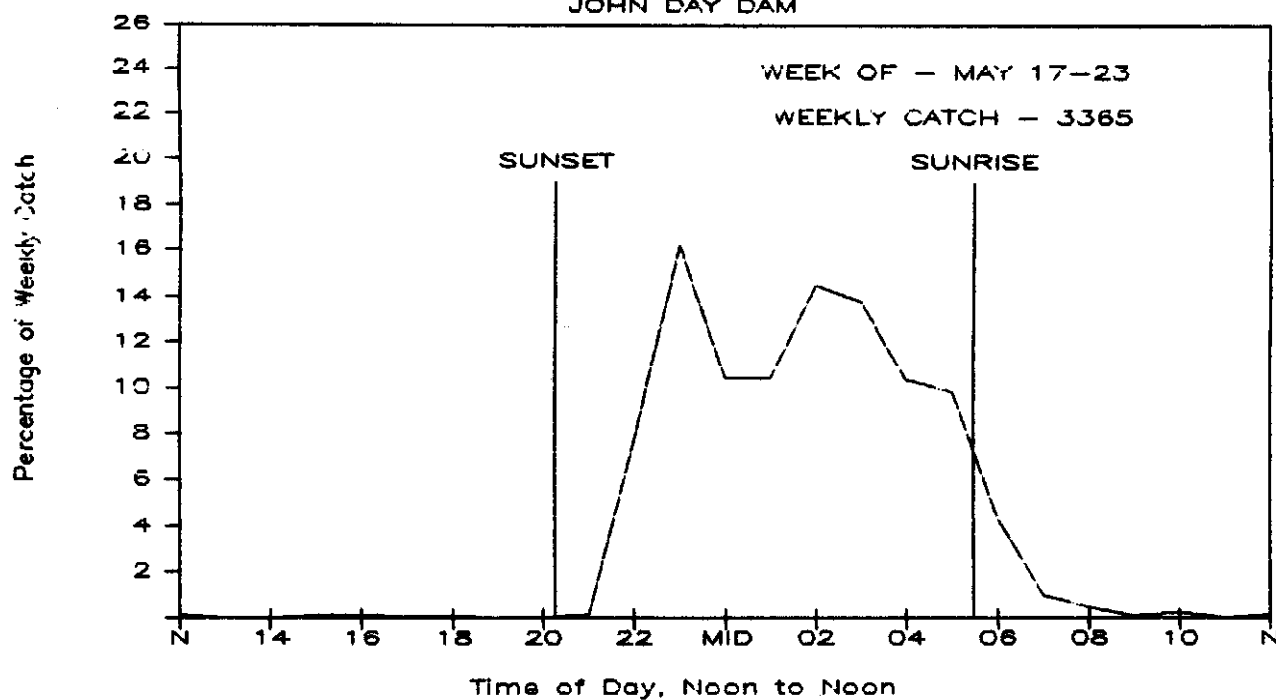


FIGURE 44

WEEKLY DIEL PATTERN, COHO

JOHN DAY DAM

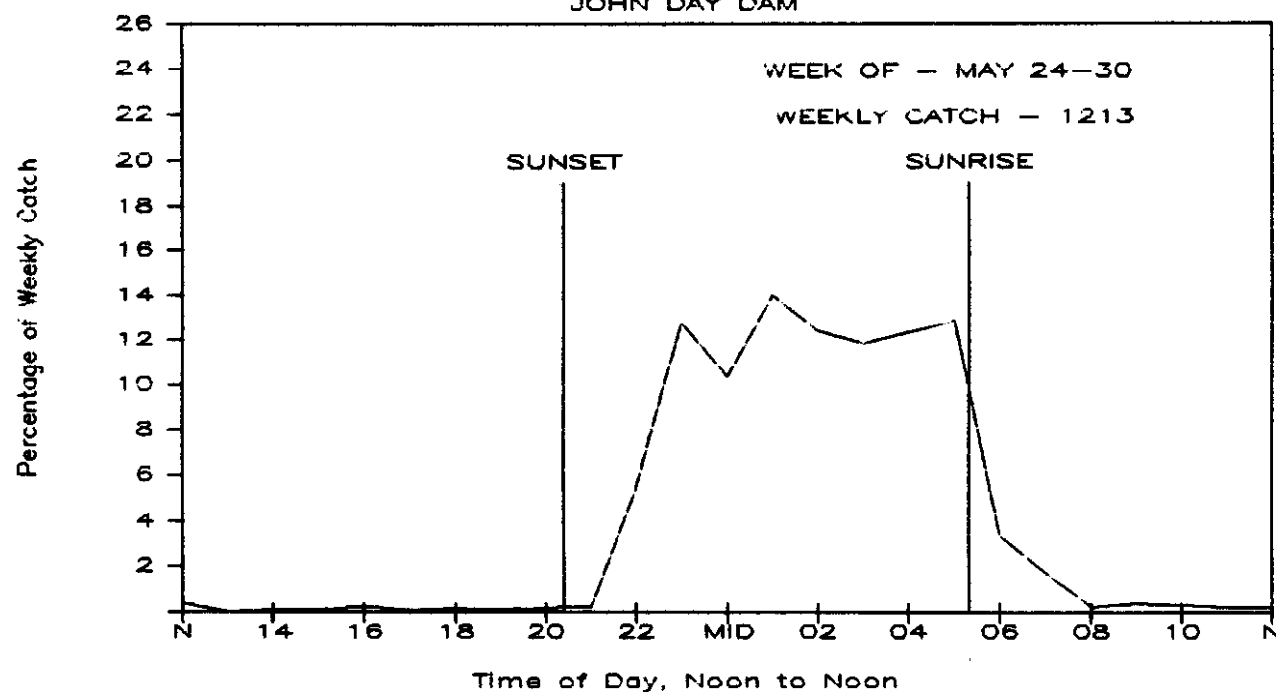


FIGURE 45

WEEKLY DIEL PATTERN, COHO

JOHN DAY DAM

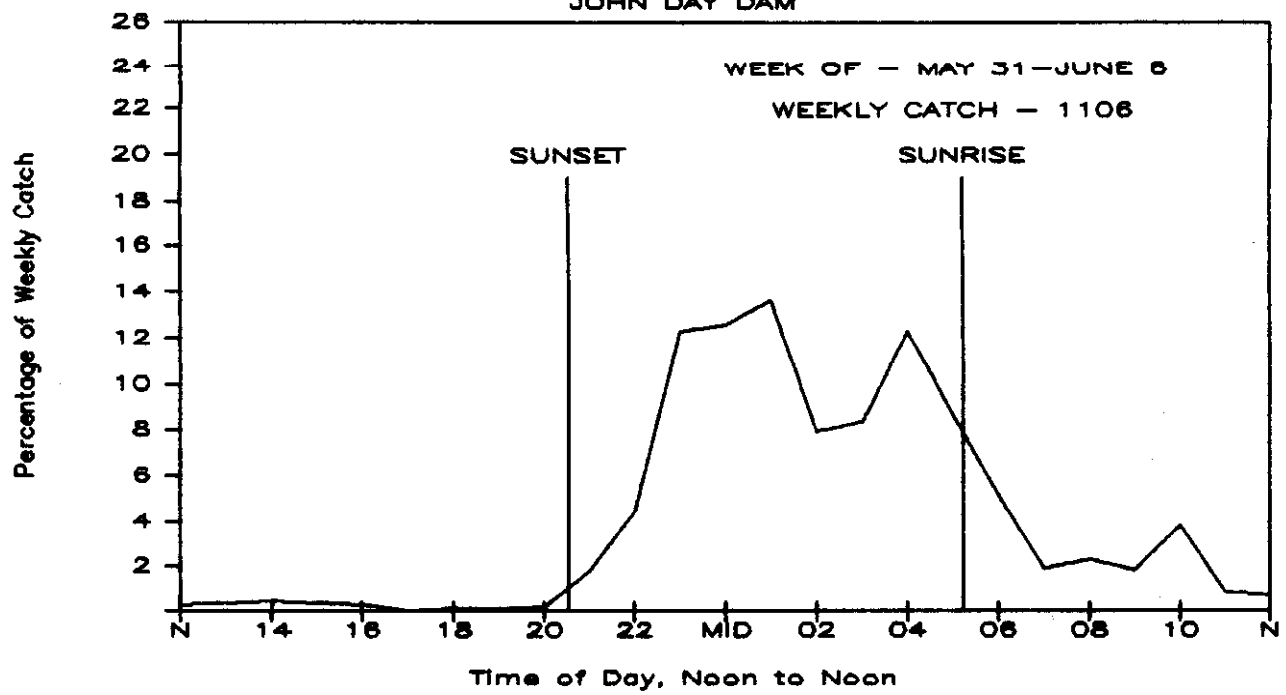


FIGURE 46

WEEKLY DIEL PATTERN, SOCKEYE

JOHN DAY DAM

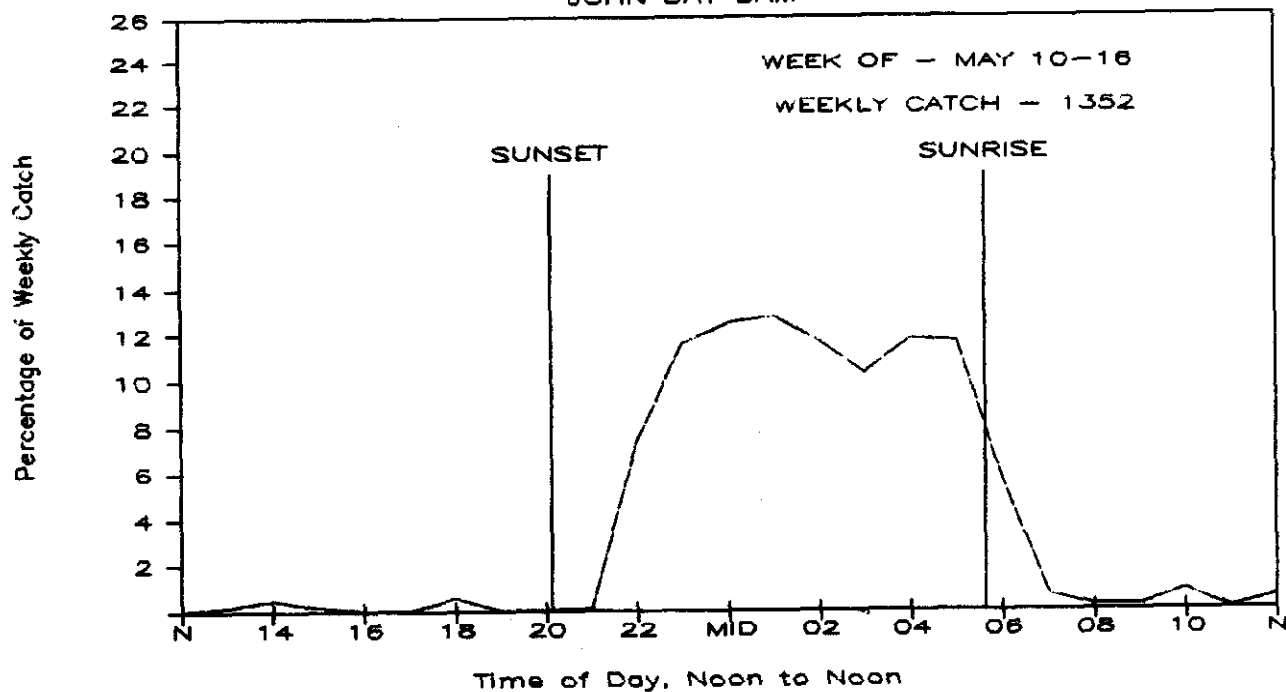


FIGURE 47

WEEKLY DIEL PATTERN, SOCKEYE

JOHN DAY DAM

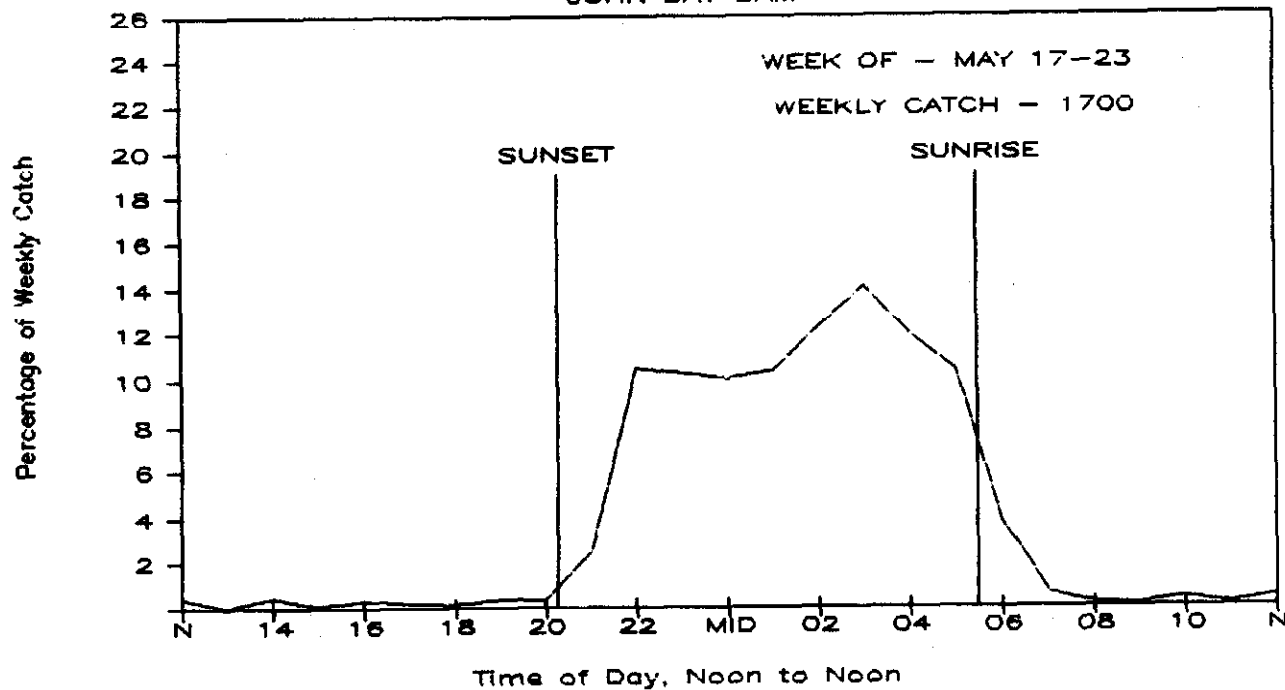


FIGURE 48

WEEKLY DIEL PATTERN, SOCKEYE

JOHN DAY DAM

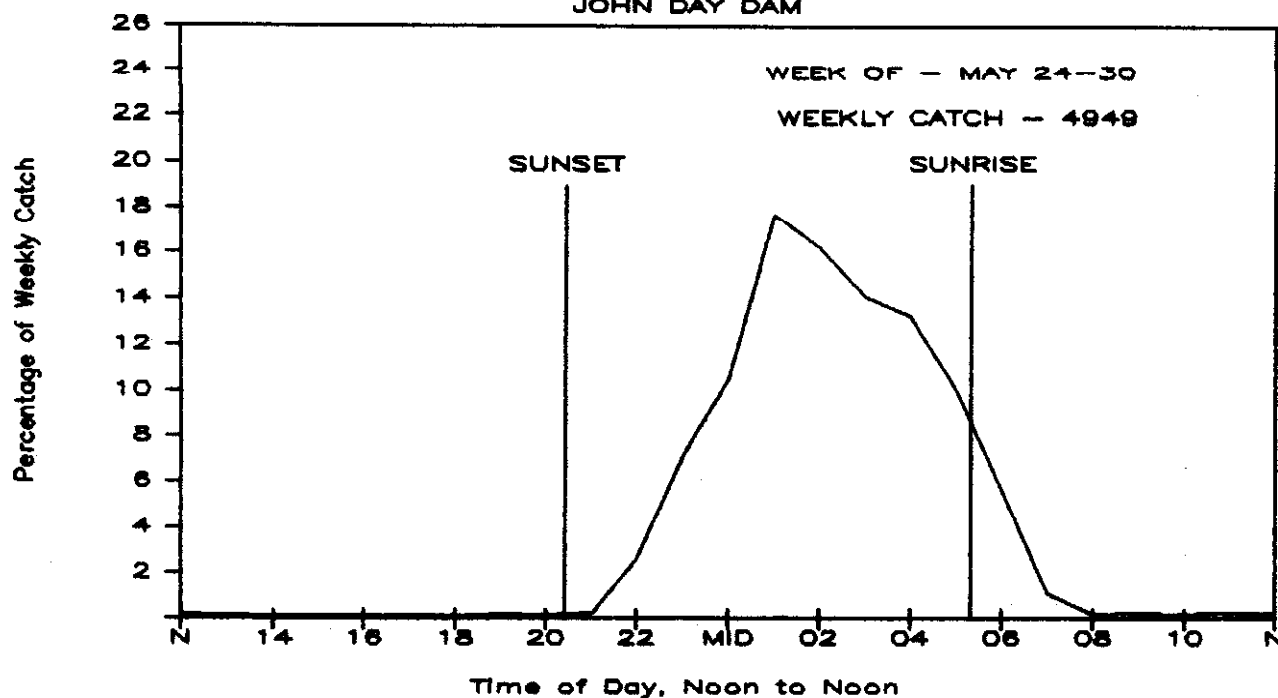


FIGURE 49

WEEKLY DIEL PATTERN, SOCKEYE

JOHN DAY DAM

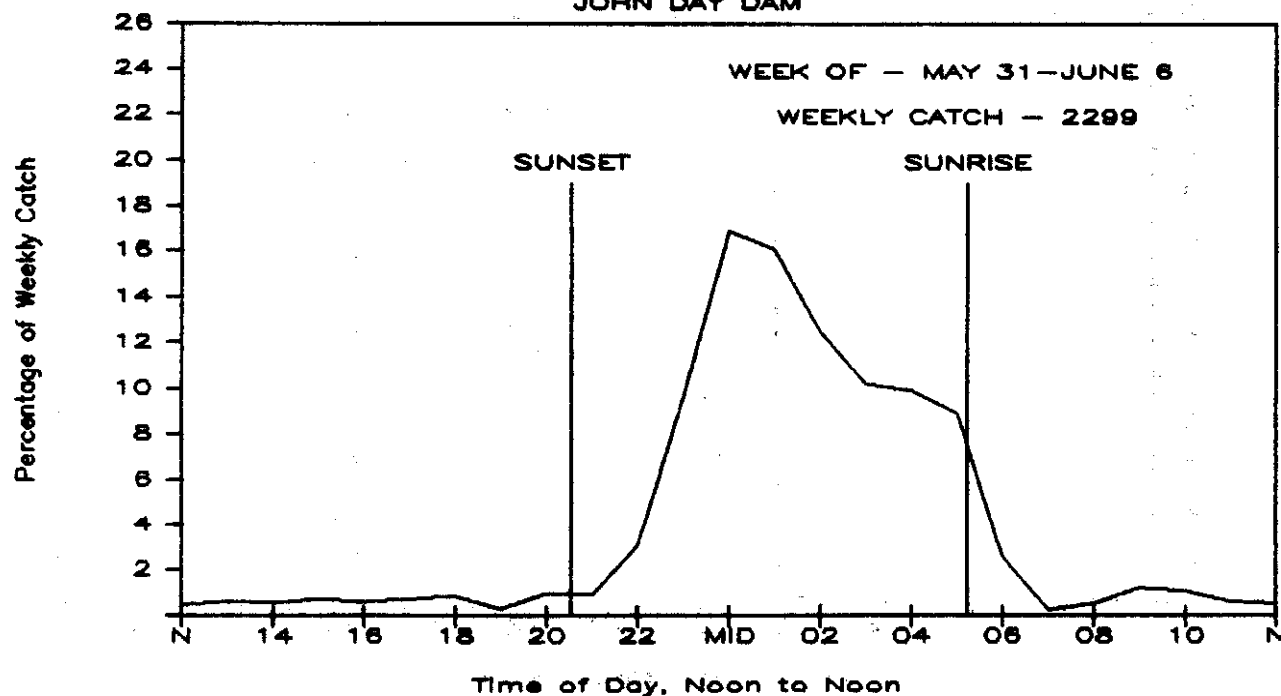


FIGURE 50

WEEKLY DIEL PATTERN, SOCKEYE

JOHN DAY DAM

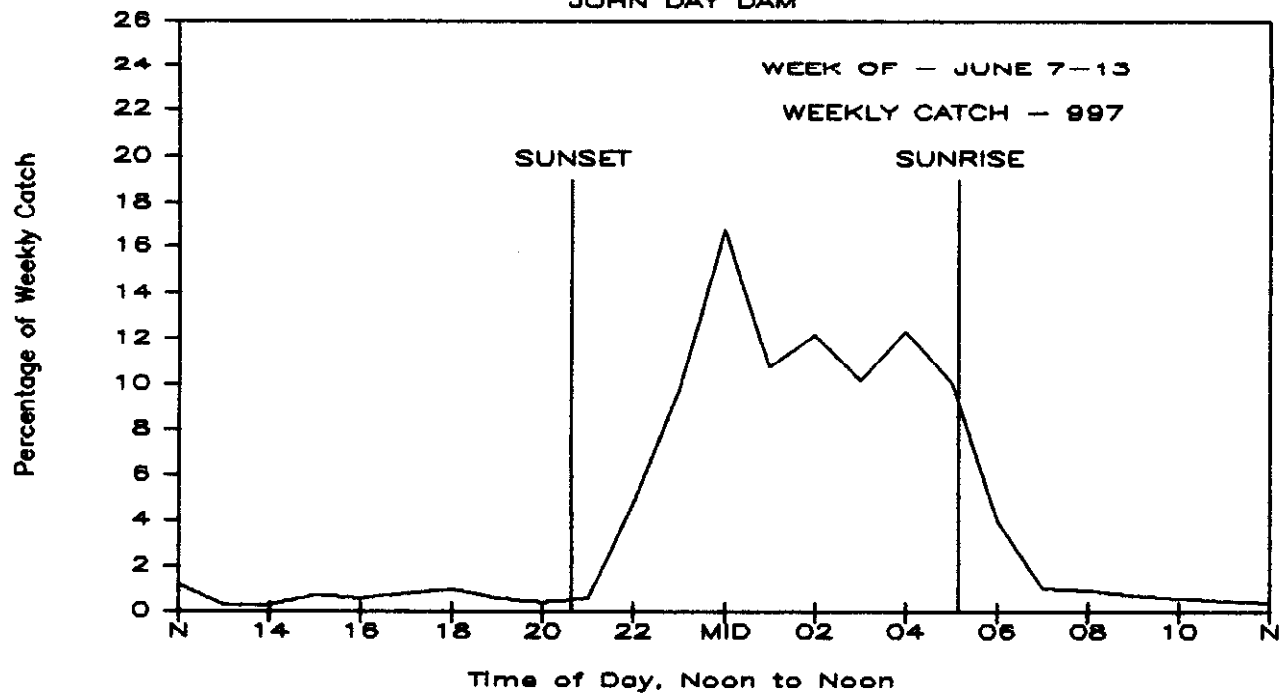


FIGURE 51

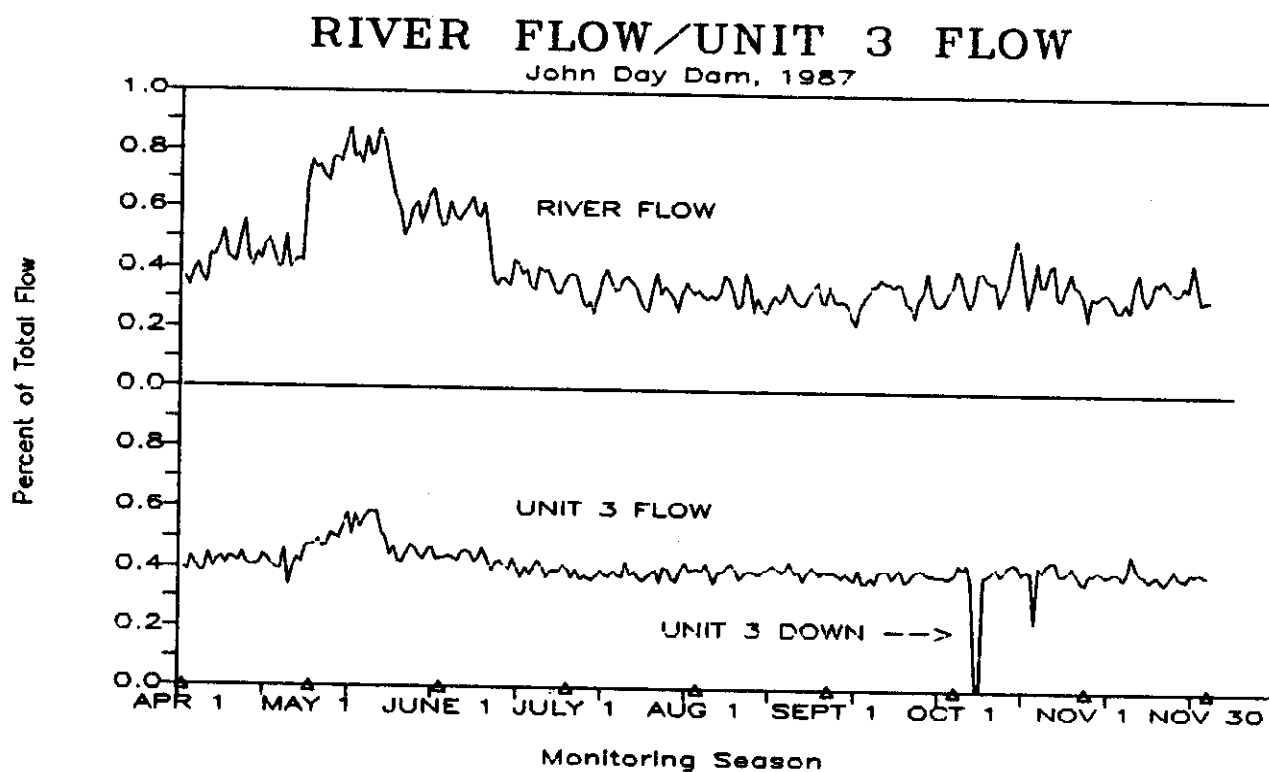


FIGURE 52

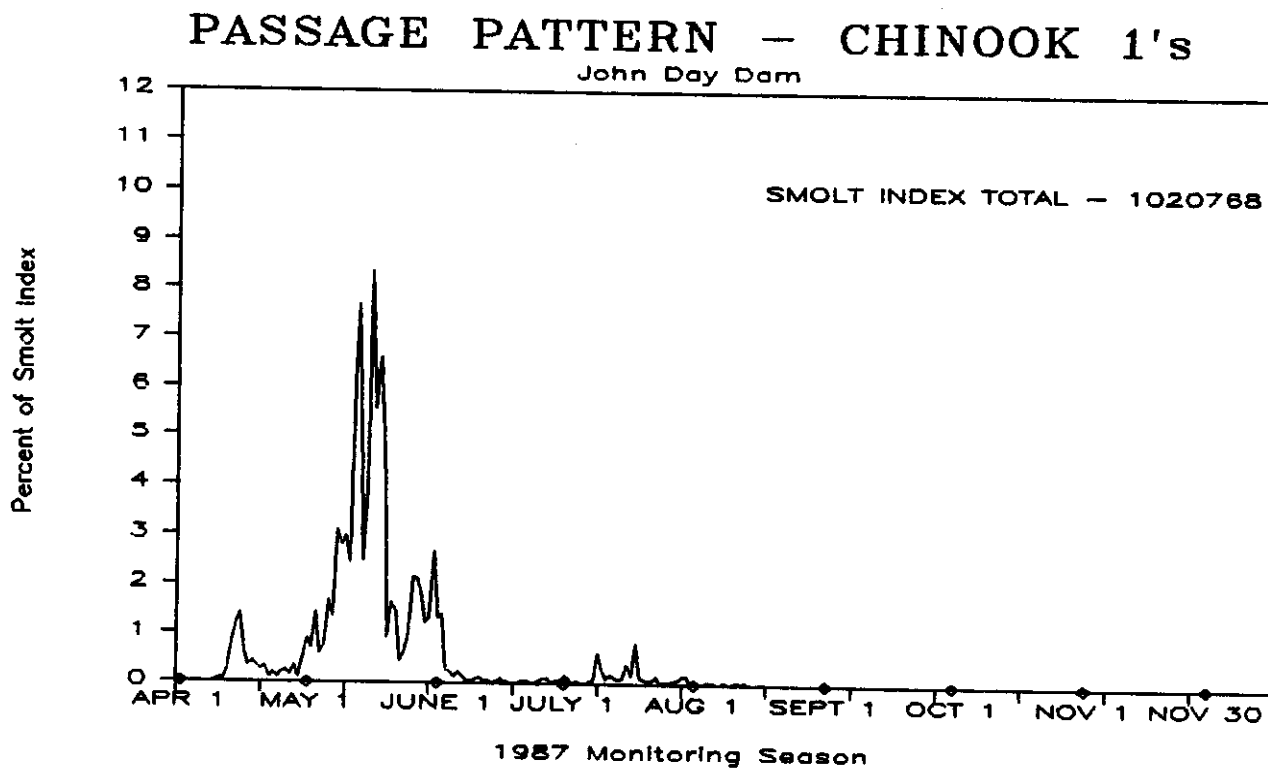


FIGURE 53

PASSAGE PATTERN — CHINOOK 0's

John Day Dam

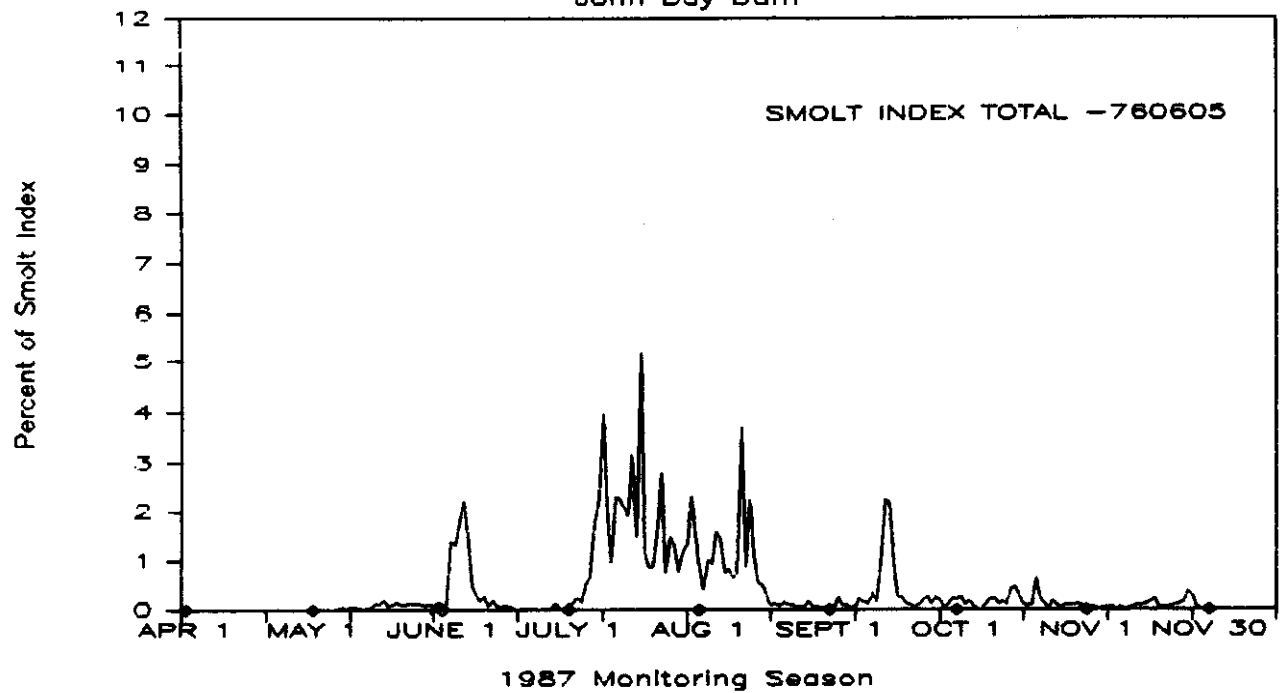


FIGURE 54

PASSAGE PATTERN — STEELHEAD

John Day Dam

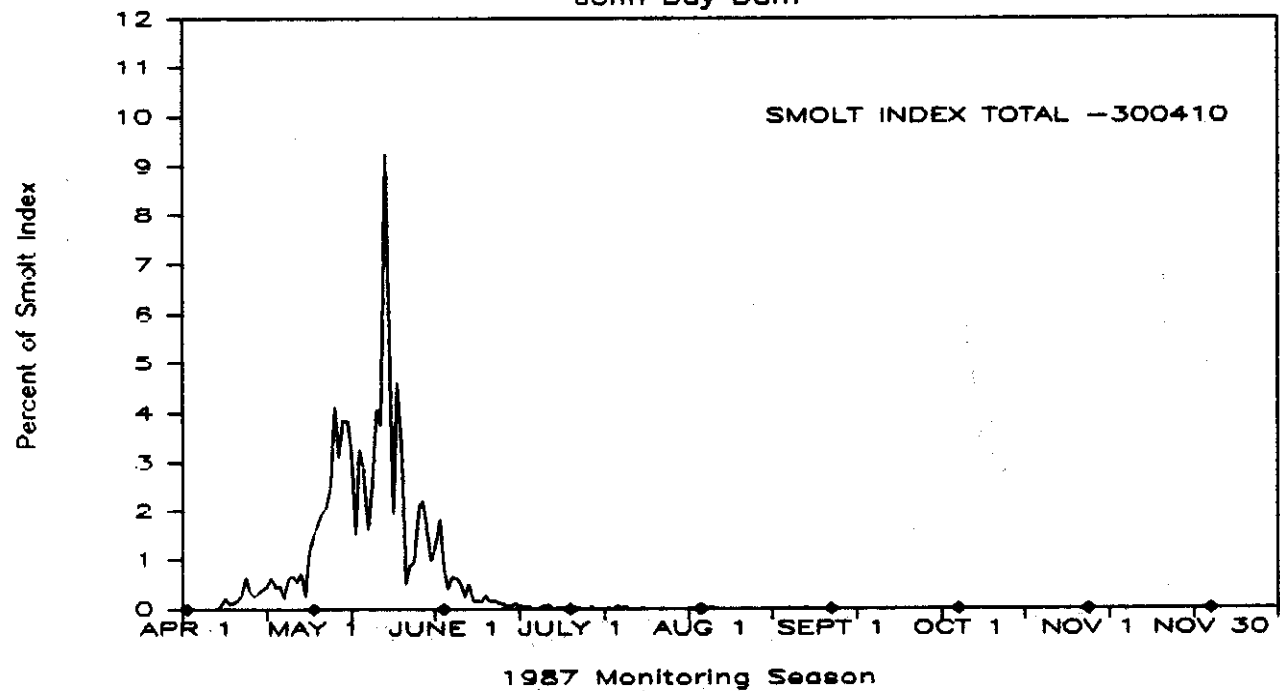


FIGURE 55

PASSAGE PATTERN — COHO

John Day Dam

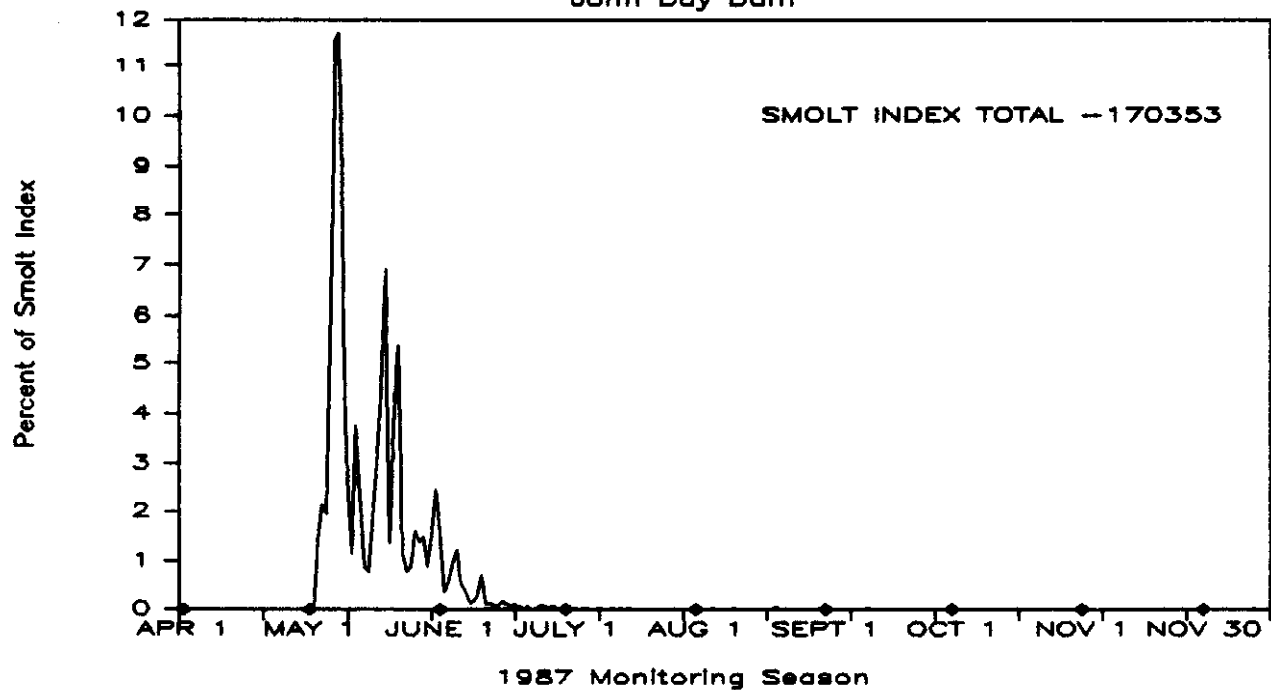


FIGURE 57

PASSAGE PATTERN — SOCKEYE

John Day Dam

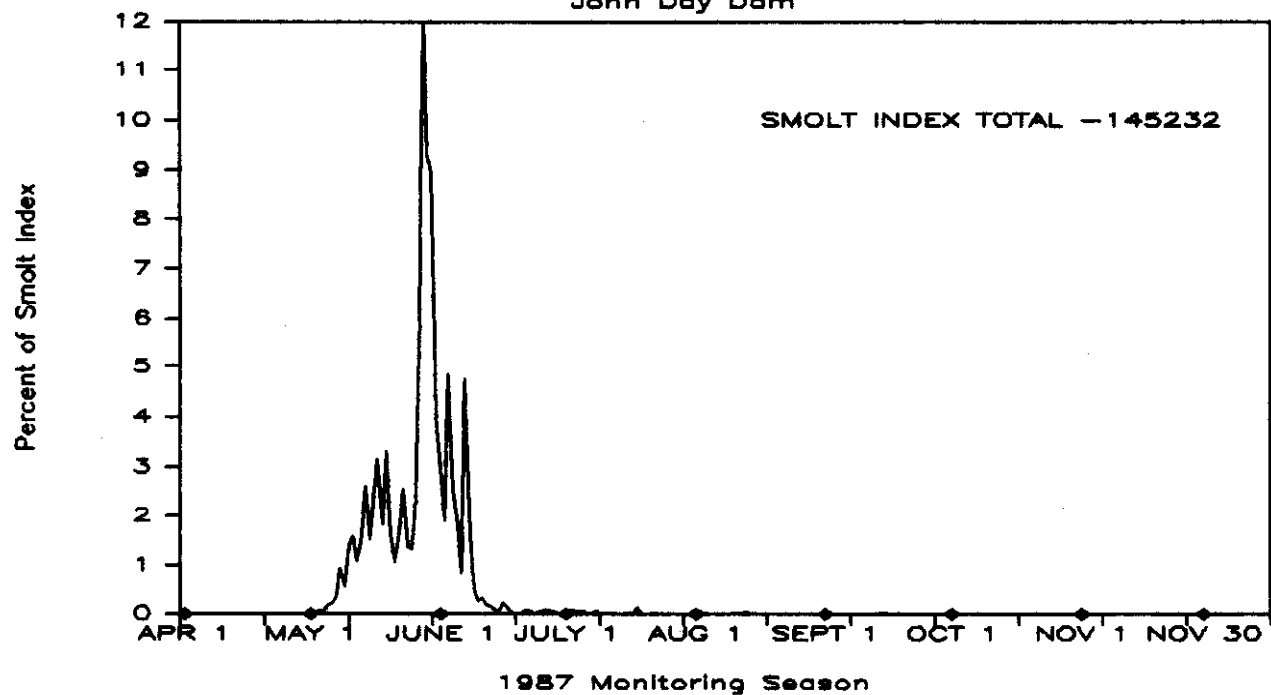


FIGURE 57

APPENDIX D
BONNEVILLE DAM - 1987

FIGURES	TITLES	PAGES
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3	CAPTURE PATTERN, CHINOOK 1's, GATEWELL 10B	D-2
4	CAPTURE PATTERN, CHINOOK 1's, GATEWELL 9B	D-2
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BONNEVILLE DAM FLOWS

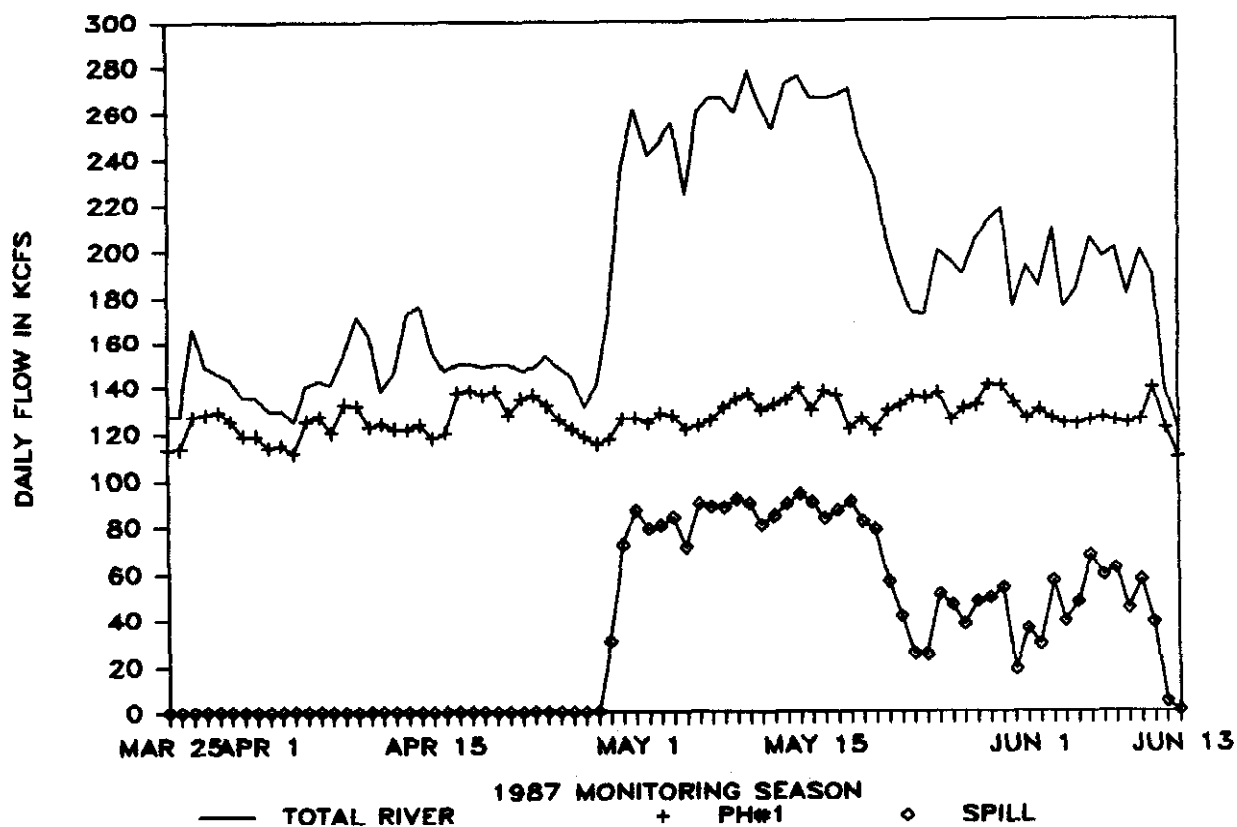


FIGURE-1

DISCHARGE THROUGH UNITS 9 AND 10

BONNEVILLE DAM

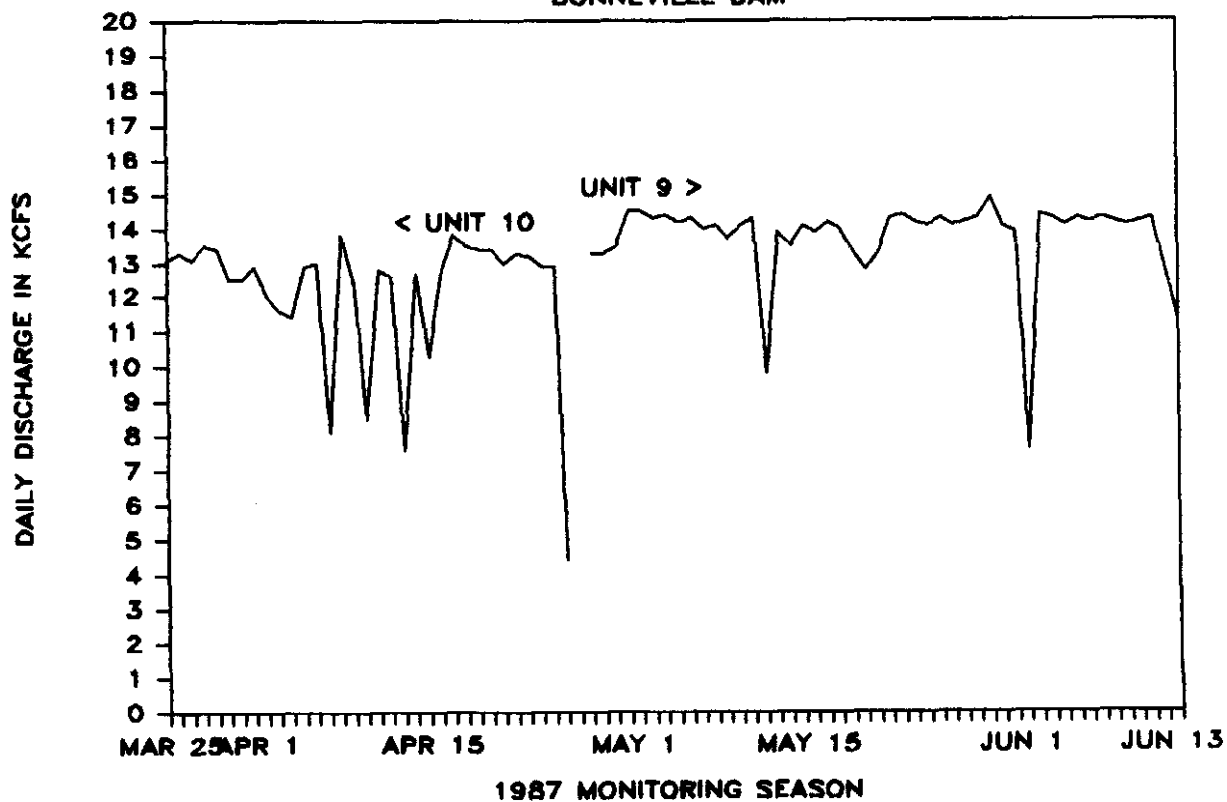
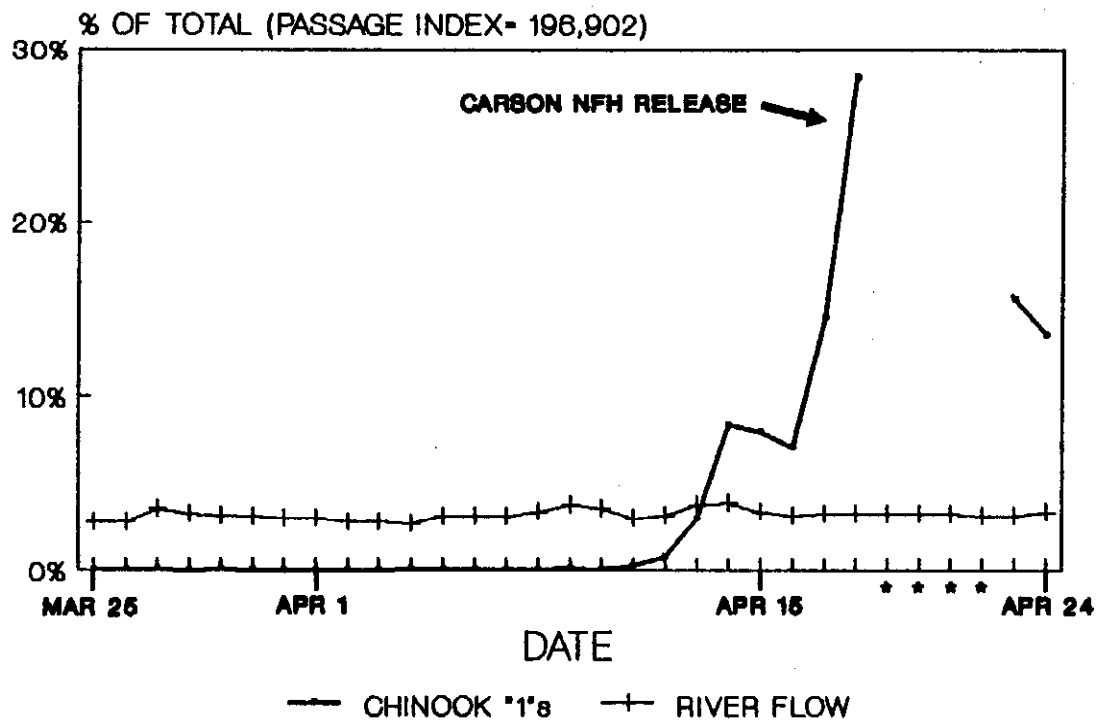


FIGURE-2

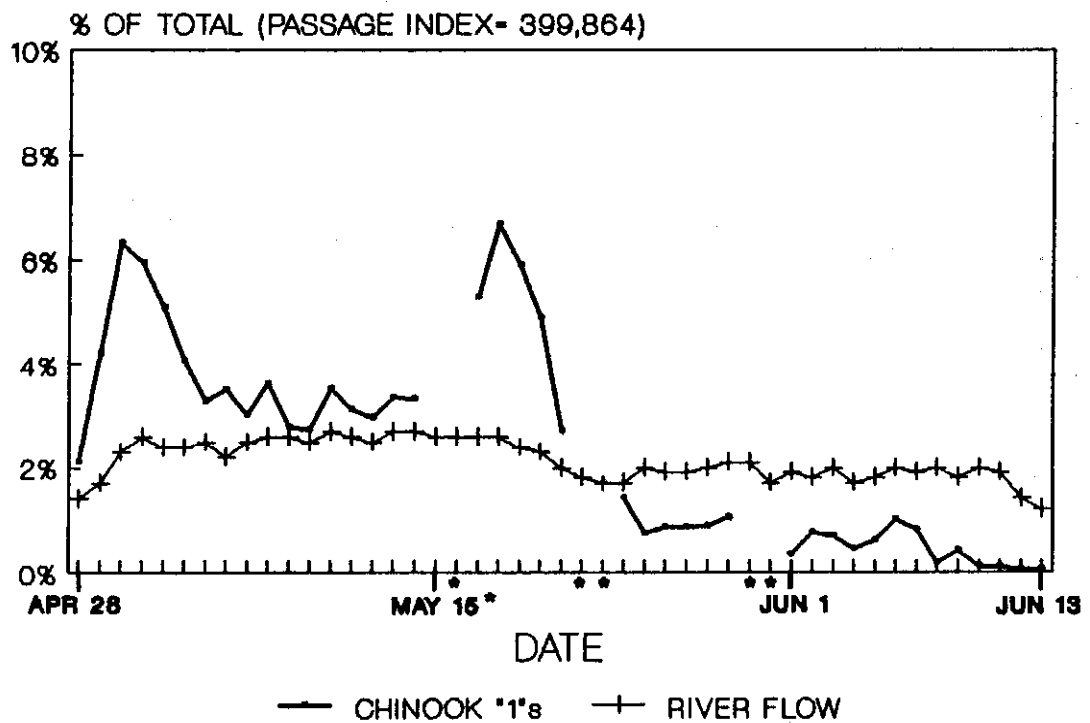
CAPTURE PATTERN, CHINOOK 1's **BONNEVILLE DAM, PH#1, GATEWELL 10B**



*INVALID SAMPLE: APRIL 19,20,21,22.

FIGURE-3

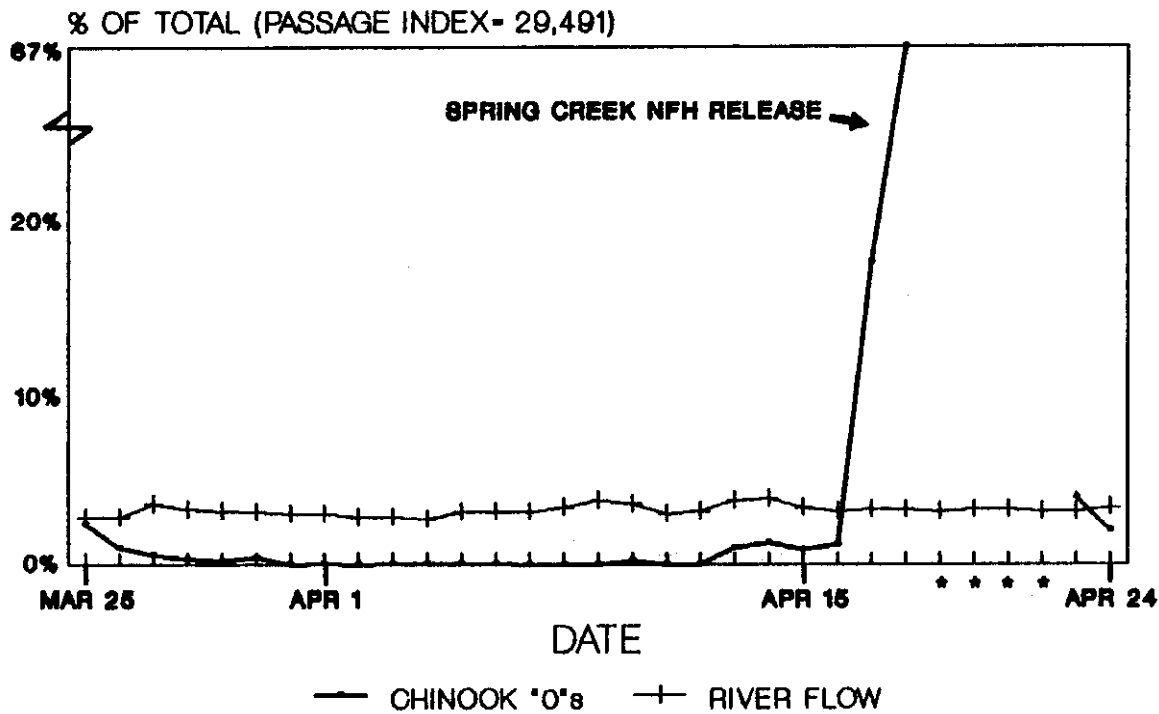
BONNEVILLE DAM, PH#1, GATEWELL 9B



*INVALID SAMPLE: MAY 15,16,22,23,30,31.

FIGURE-4

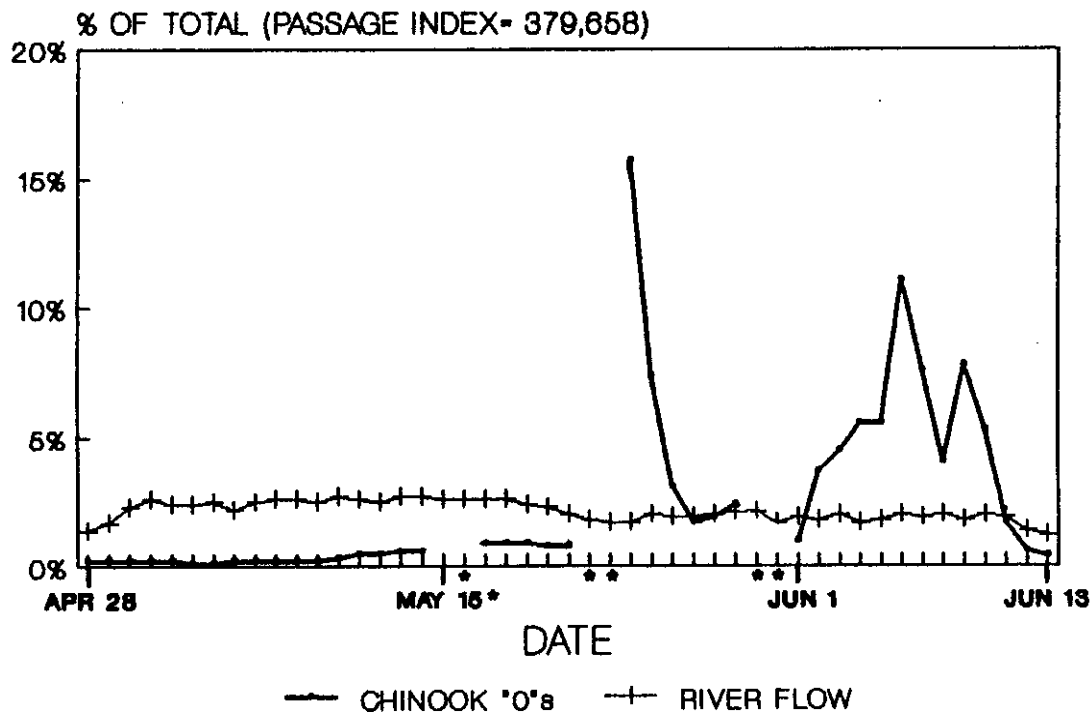
CAPTURE PATTERN, CHINOOK O's **BONNEVILLE DAM, PH#1, GATEWELL 10B**



*INVALID SAMPLE: APRIL 19,20,21,22.

FIGURE-5

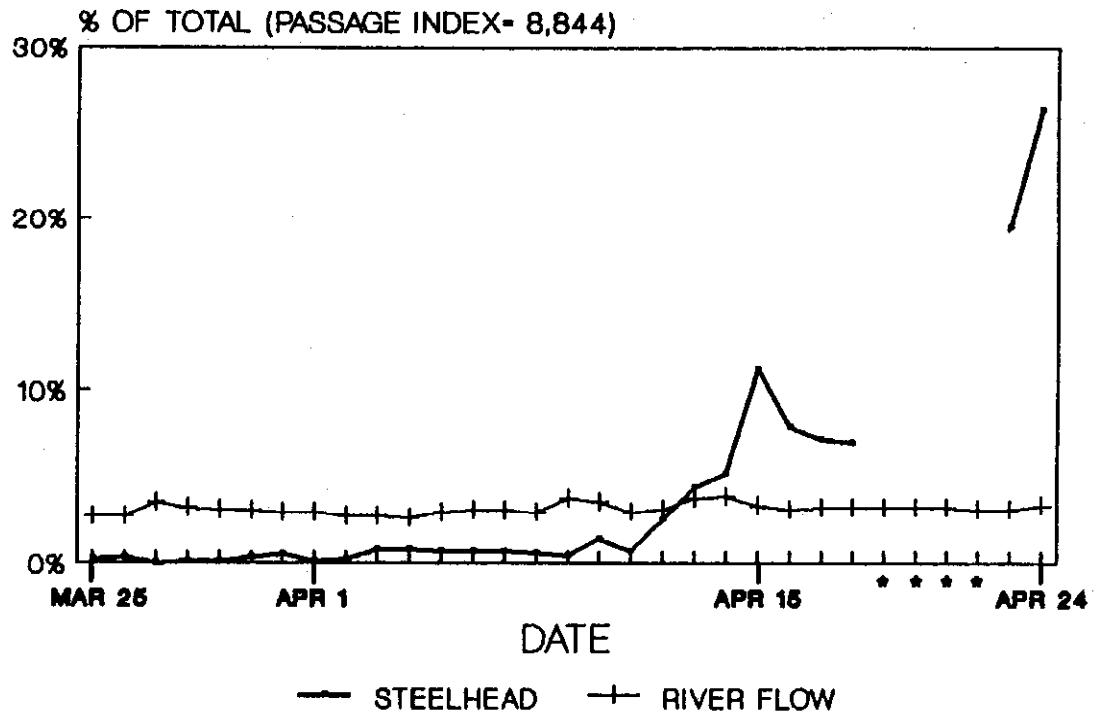
BONNEVILLE DAM, PH#1, GATEWELL 9B



*INVALID SAMPLE: MAY 15,16,22,23,30,31.

FIGURE-6

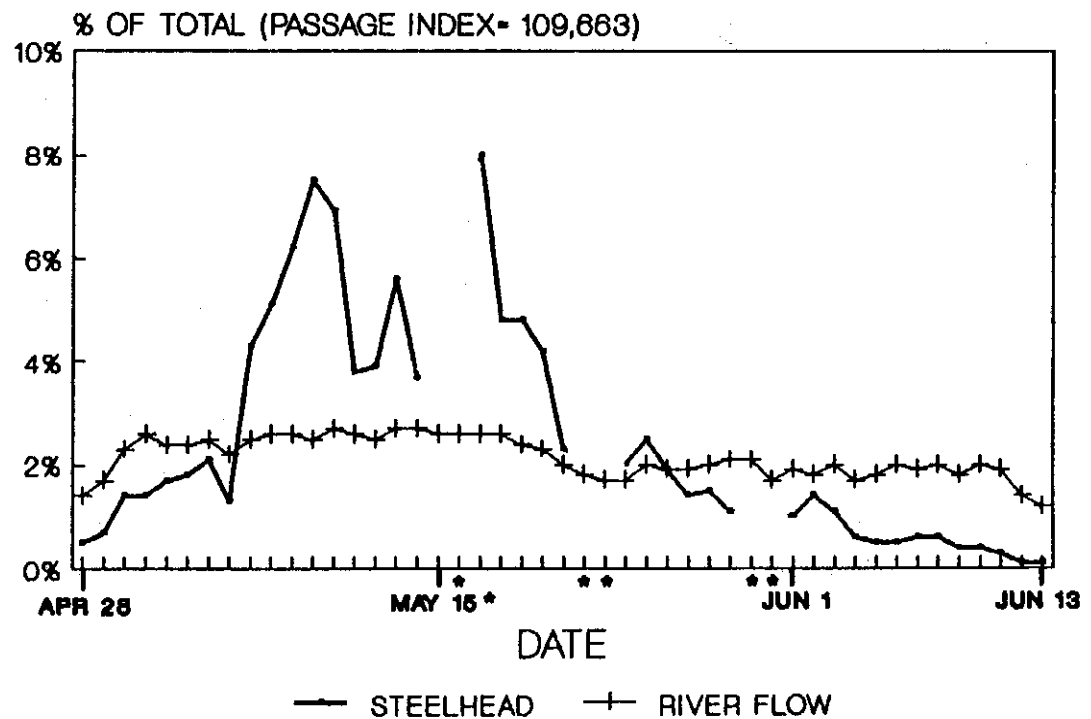
CAPTURE PATTERN, STEELHEAD **BONNEVILLE DAM, PH#1, GATEWELL 10B**



*INVALID SAMPLE: APRIL 19,20,21,22.

FIGURE-7

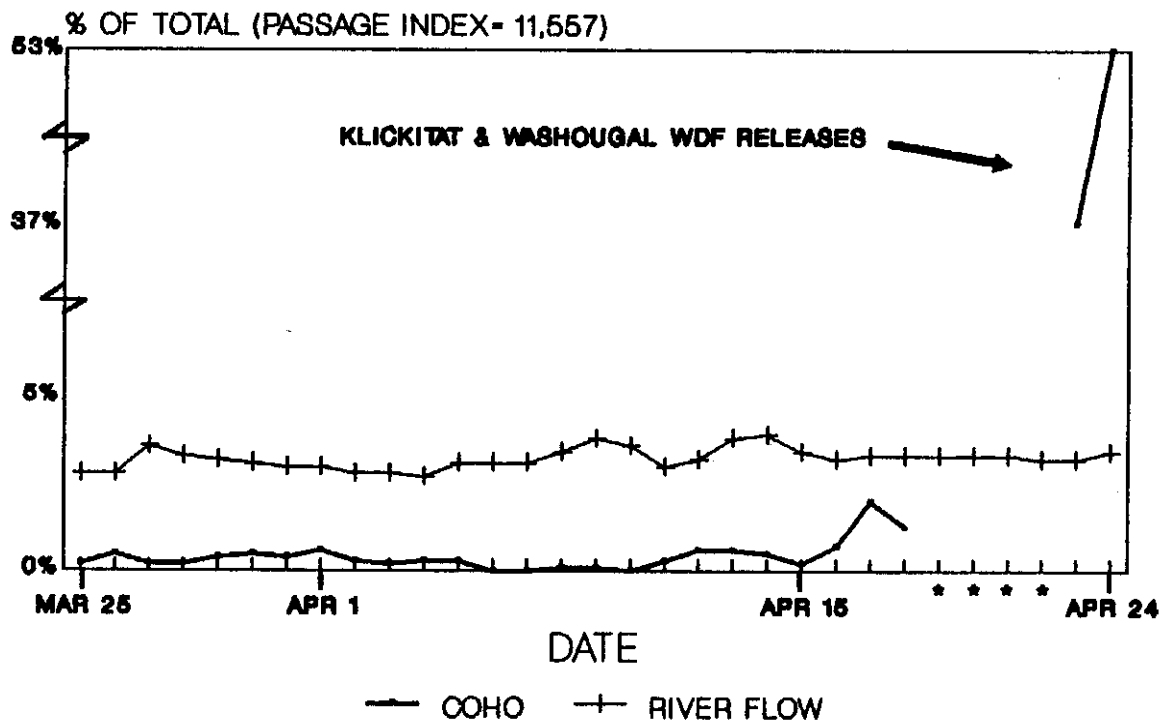
BONNEVILLE DAM, PH#1, GATEWELL 9B



*INVALID SAMPLE: MAY 15,16,22,23,30,31.

FIGURE-8

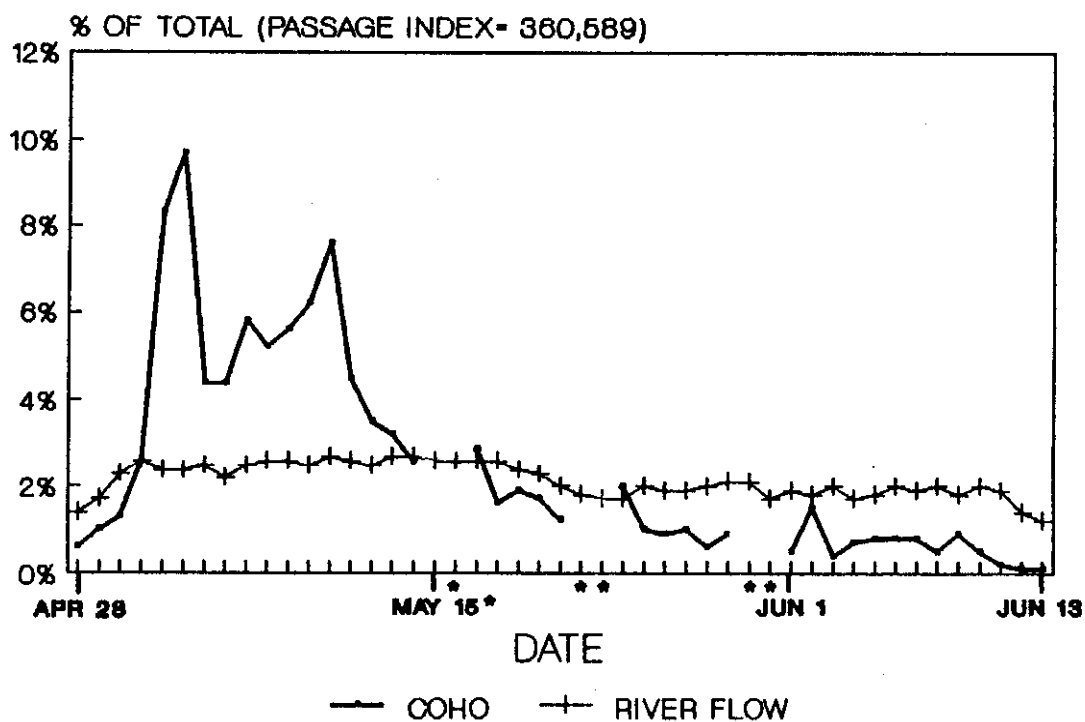
CAPTURE PATTERN, COHO **BONNEVILLE DAM, PH#1, GATEWELL 10B**



*NO SAMPLE: APRIL 19,20,21,22.

FIGURE-9

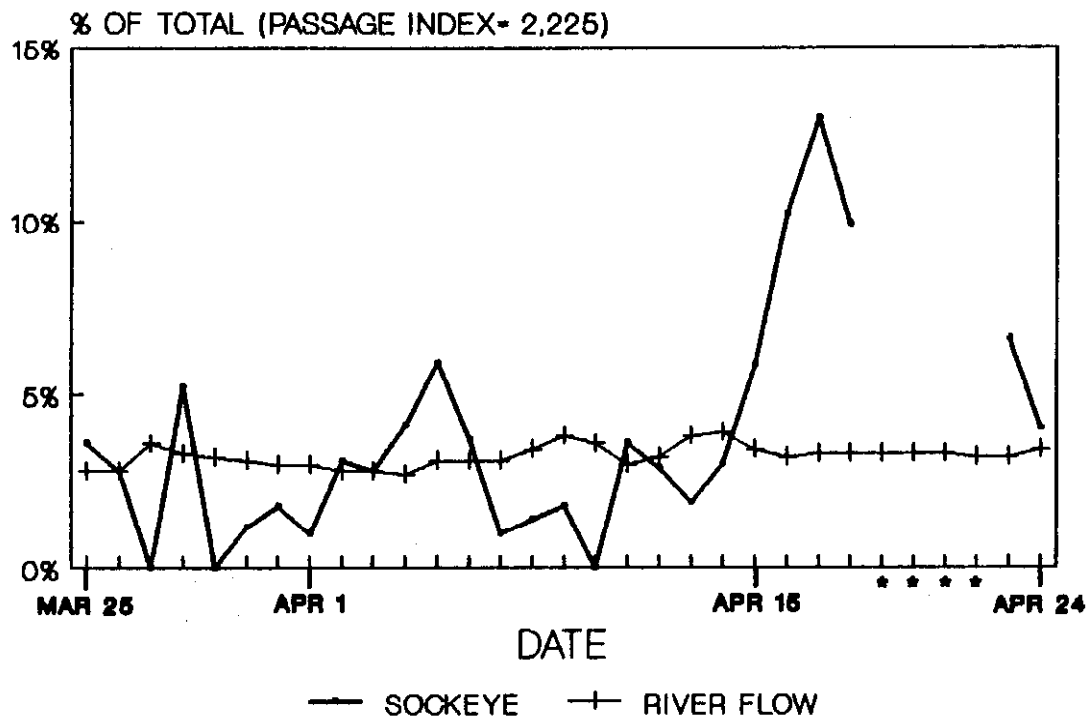
BONNEVILLE DAM, PH#1, GATEWELL 9B



*NO SAMPLE: MAY 15,16,22,23,30,31.

FIGURE-10

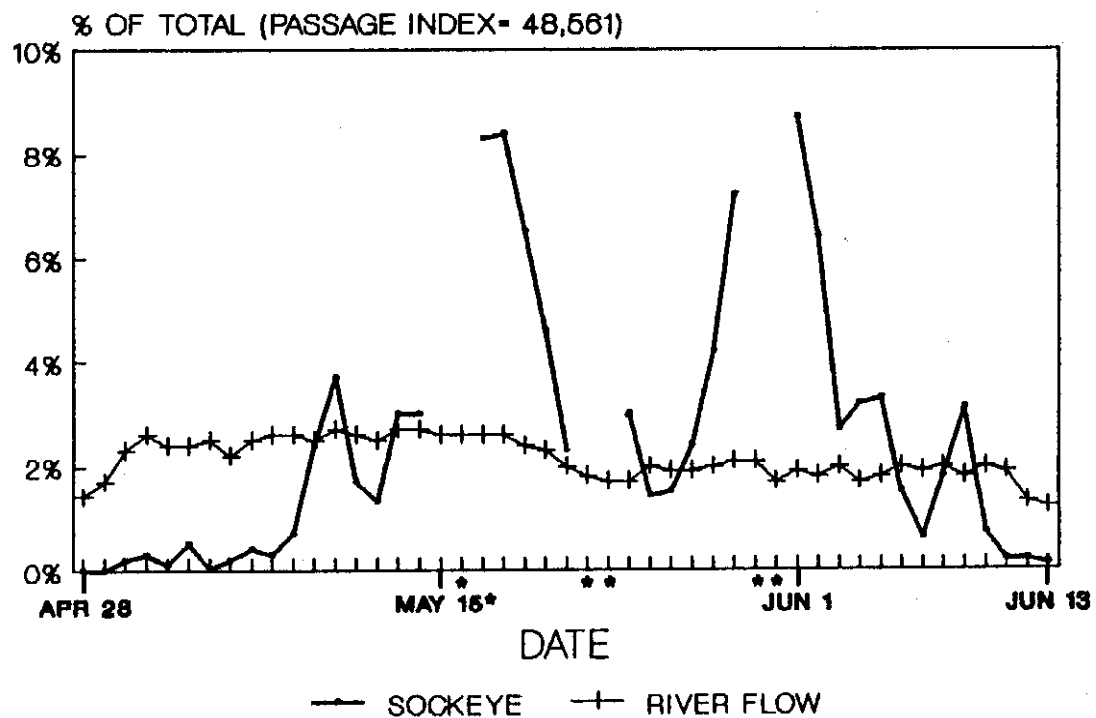
CAPTURE PATTERN, SOCKEYE **BONNEVILLE DAM, PH#1, GATEWELL 10B**



•NO SAMPLE: APRIL 19,20,21,22.

FIGURE-11

BONNEVILLE DAM, PH#1, GATEWELL 9B

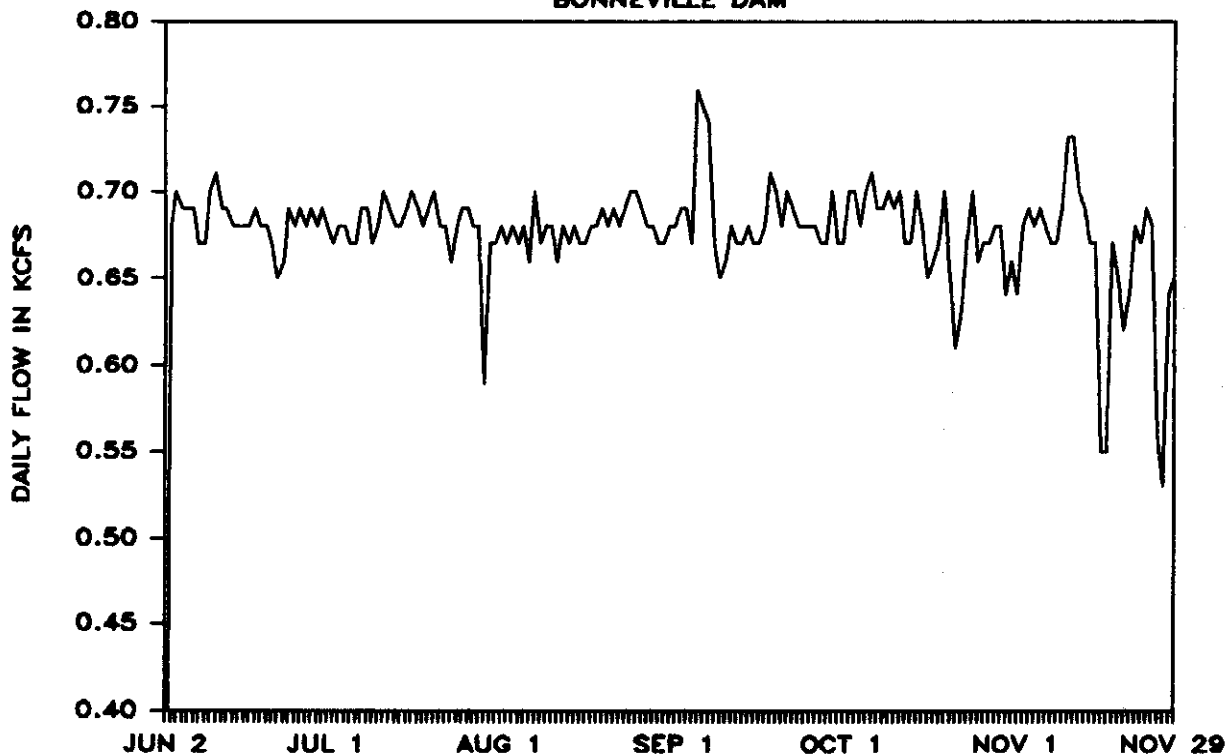


•NO SAMPLE: MAY 15,16,22,23,30,31.

FIGURE-12

AUXILLARY WATER SUPPLY FLOW

BONNEVILLE DAM

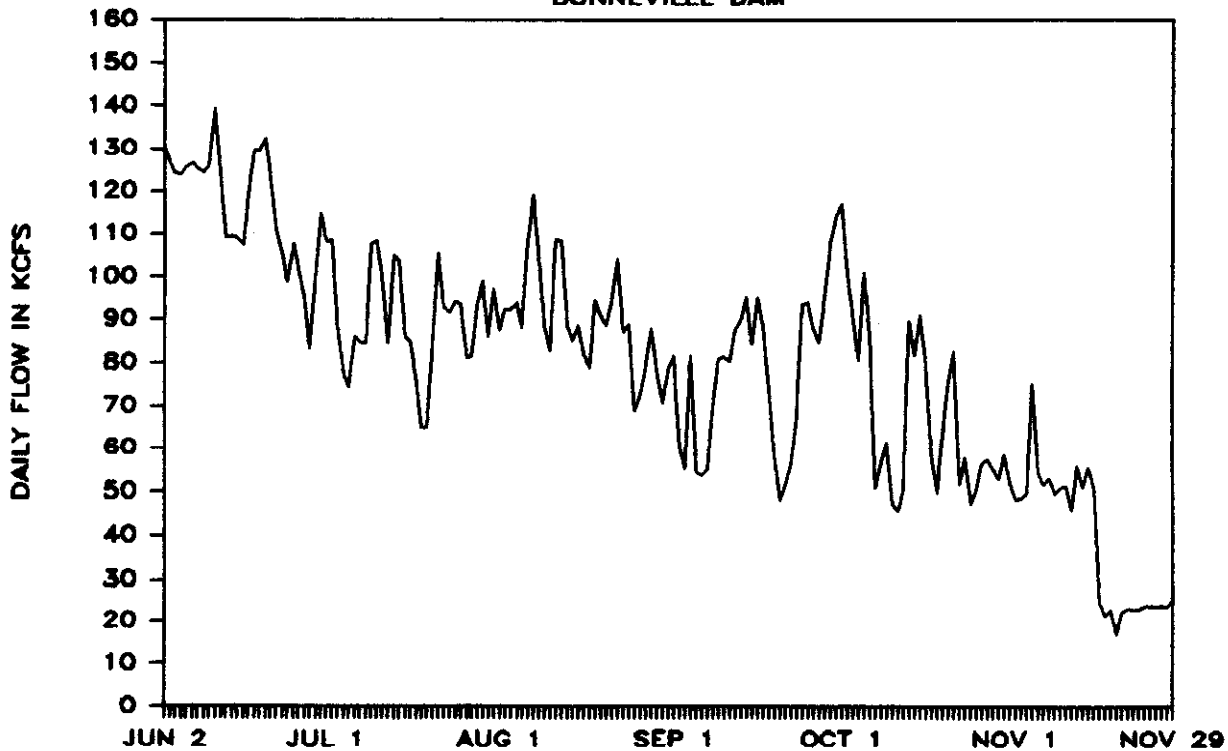


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FIGURE-13

FIRST POWERHOUSE FLOW

BONNEVILLE DAM



1987 MONITORING SEASON

FIGURE-14

CAPTURE PATTERN, CHINOOK 1's

BONNEVILLE DAM, PH#1, AWS TRAP

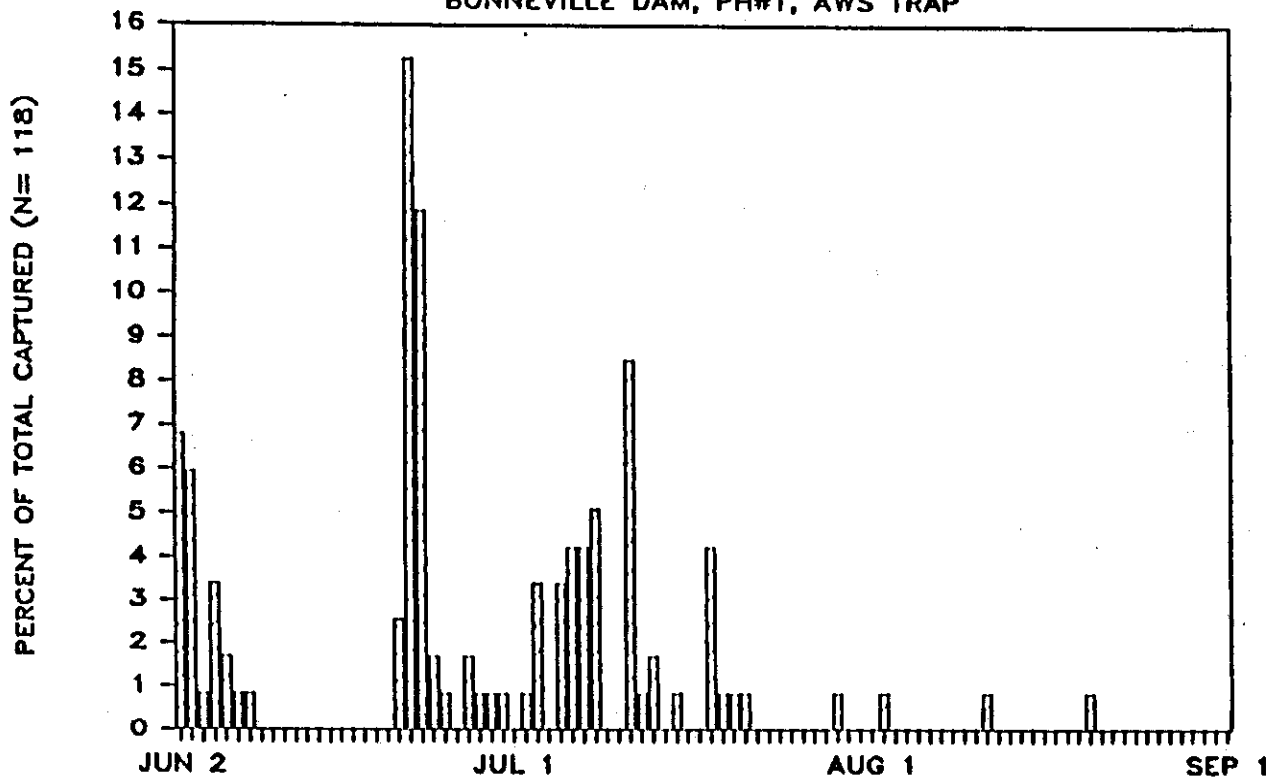


FIGURE-15

FISH CAPTURE PATTERN, CHINOOK 0's

BONNEVILLE DAM, PH#1, AWS TRAP

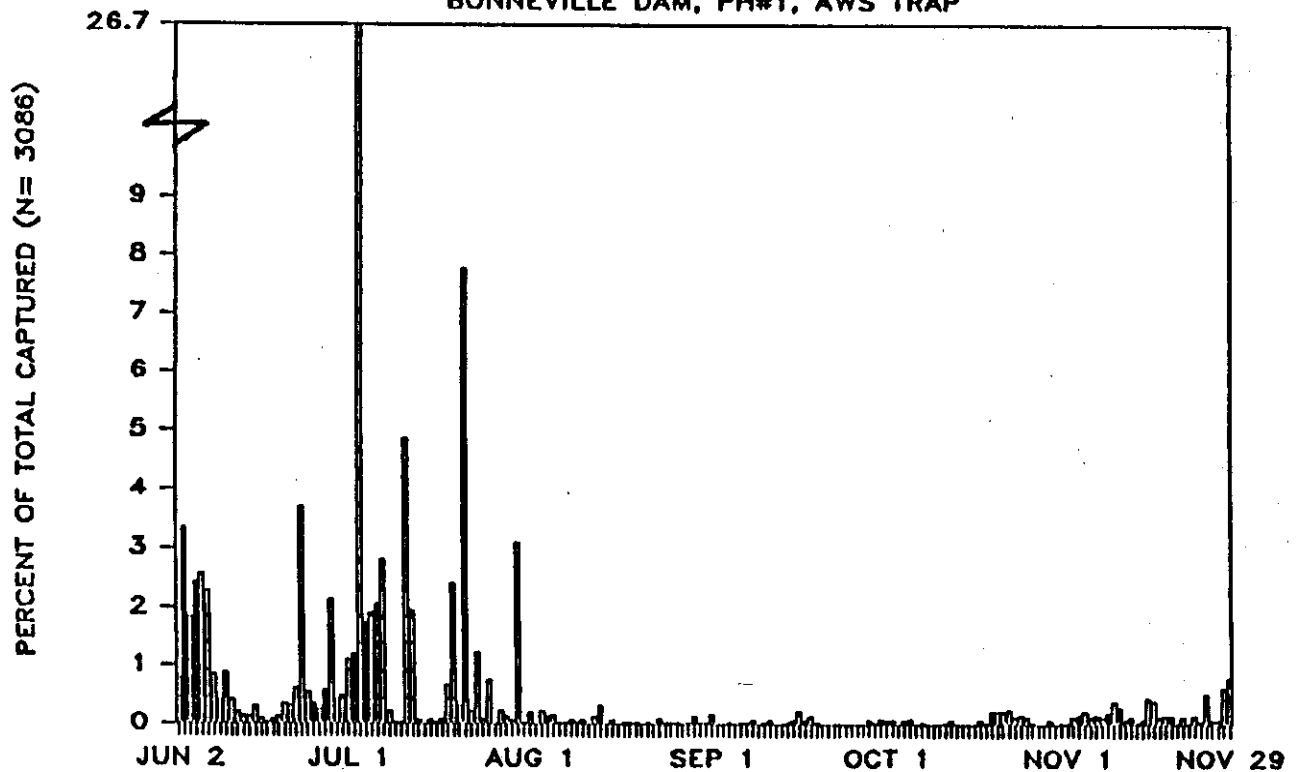
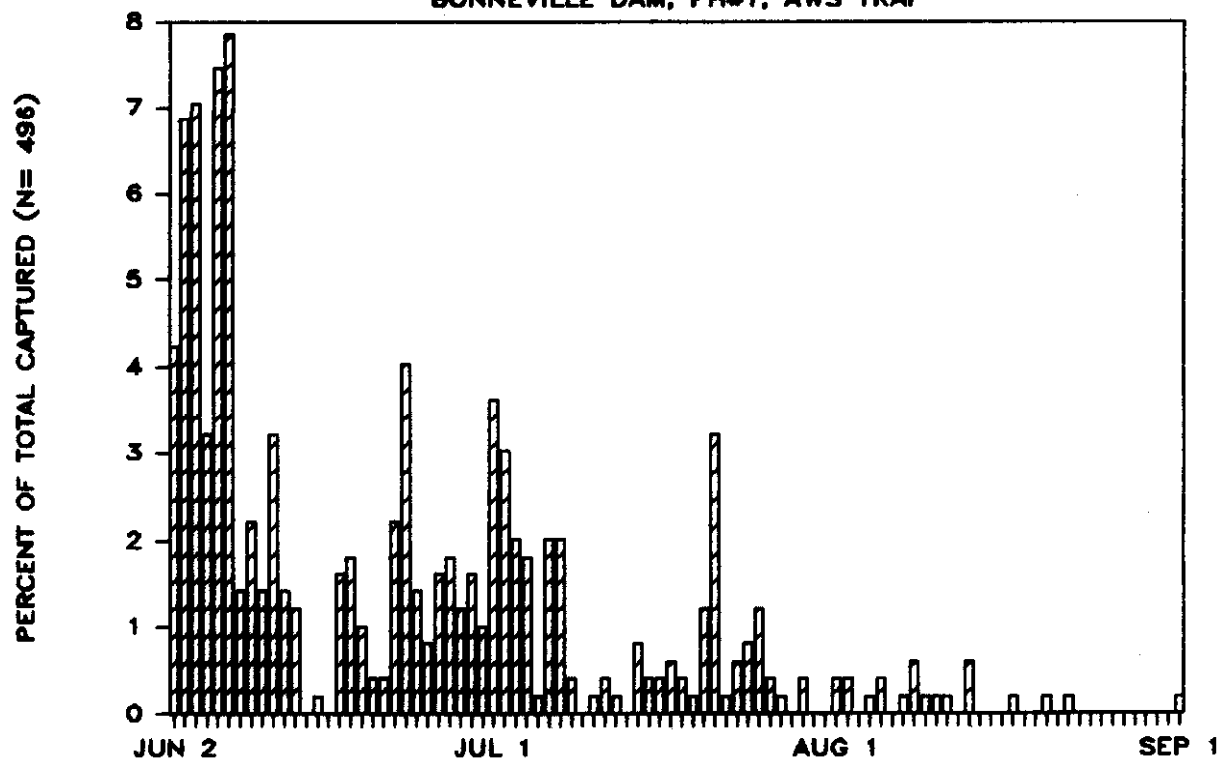


FIGURE-16

CAPTURE PATTERN, STEELHEAD

BONNEVILLE DAM, PH#1, AWS TRAP

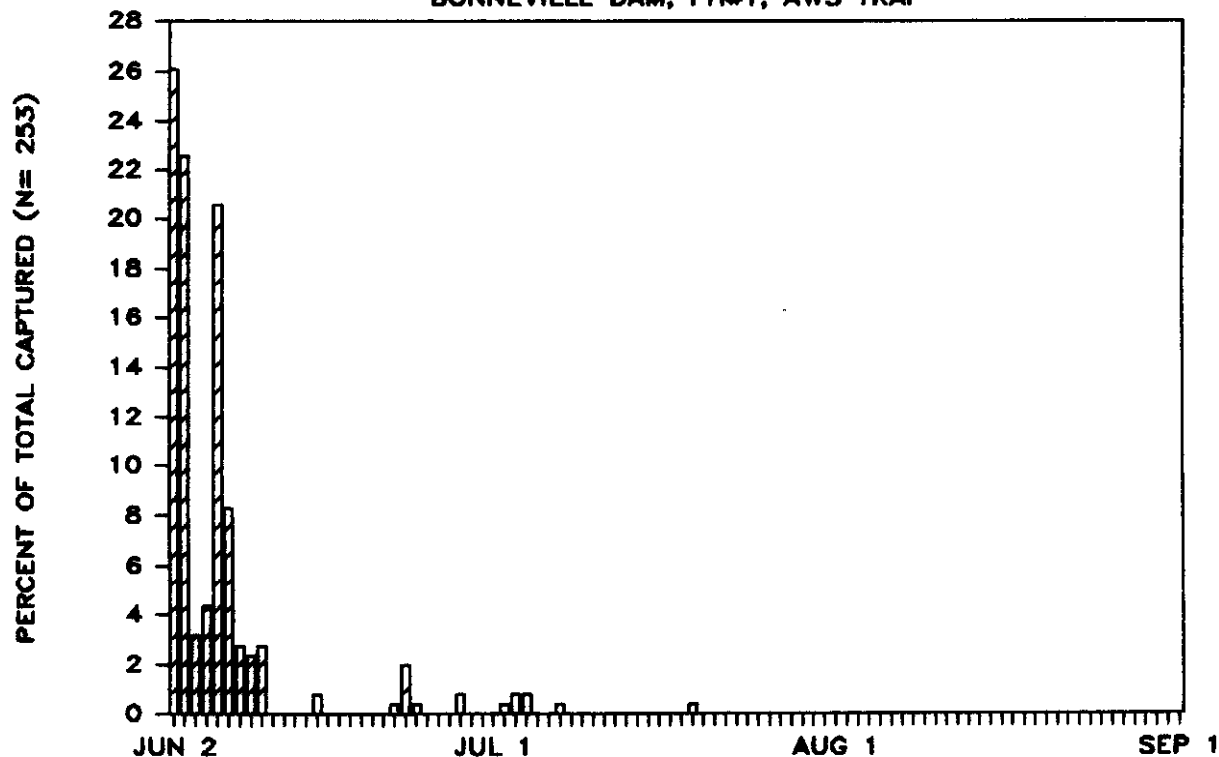


1987 MONITORING SEASON

FIGURE-17

CAPTURE PATTERN, COHO

BONNEVILLE DAM, PH#1, AWS TRAP



1987 MONITORING SEASON

FIGURE-18

CAPTURE PATTERN, SOCKEYE

BONNEVILLE DAM, PH#1, AWS TRAP

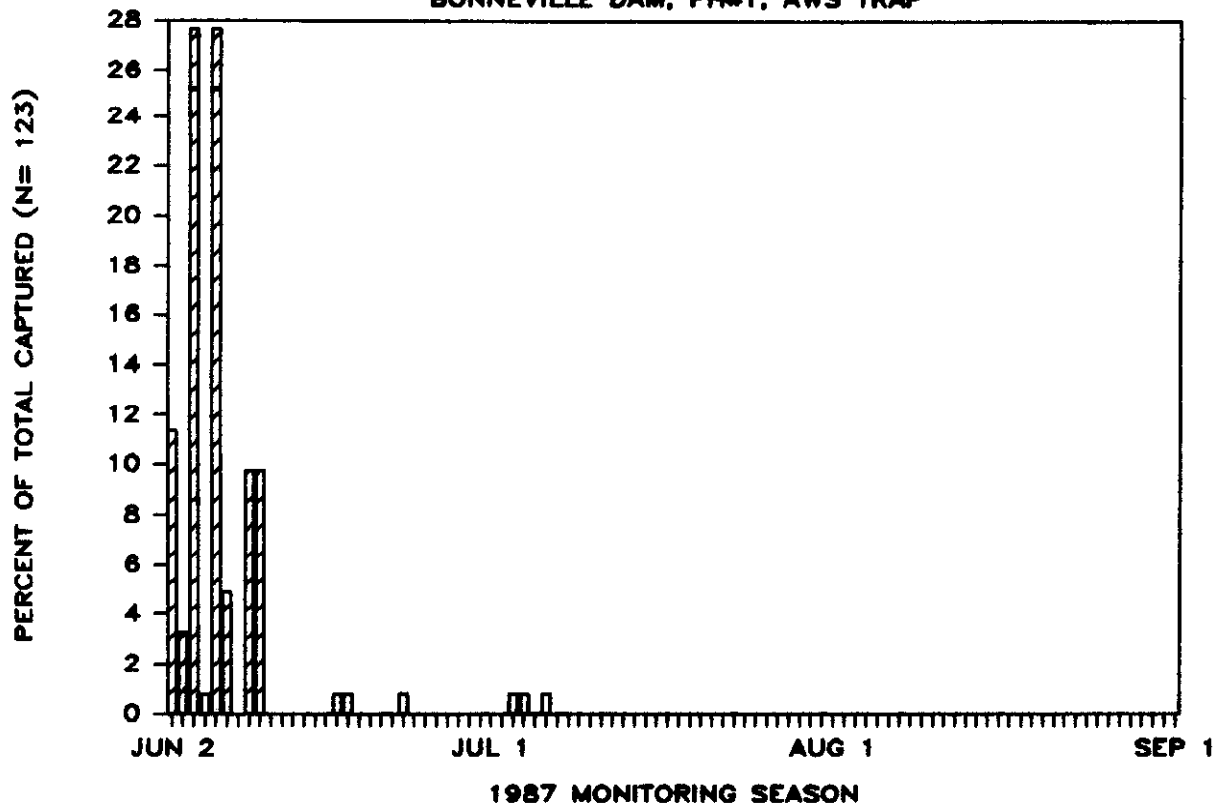


FIGURE-19